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WHOLE NO. 330

WHY DO TEACHERS' ASSOCIATIONS HAVE CONVENTIONS?

Teachers are justified in asking—Do we get our money's worth when we attend conventions? It is not easy to judge the values received in dollars and cents, but teachers who attend conventions regularly will testify that they always get new ideas and plans for improving their teaching. Then, too, they meet new acquaintances and make more friends. This gradual accumulation of new experiences gives broader perspective to teaching.

What do teachers want most in a convention? The general and sectional officers of the Central Association of Science and Mathematics Teachers have held two meetings recently to find the answer to this question. A large number of teachers were asked to list the most important issues facing mathematics and science teachers today. Teachers were also asked to give the factors which contributed most to the successful conduct of a convention.

After a thorough discussion of all of the suggestions offered, the officers have planned to provide for teachers who attend the convention of the Association at the LaSalle Hotel in Chicago on November 25th and 26th:

- (1) Speakers who can give the foundation principles for curriculum changes in science and mathematics. These speakers will answer the question—"What kinds of programs will we have in science and mathematics ten years from now?" These discussions will be of interest and value to teachers at all school levels. The speakers will appear on the program, Friday morning, Nov. 25th.

- (2) Sectional programs that will give specific classroom helps. The chairmen of sections have planned unusually interesting and worthwhile programs. In each of the sections the last speaker will discuss the topic—"New Materials and Equipment For The Teaching of ——" (The subject of that section). These programs will be given Friday afternoon, Nov. 25th.
- (3) Special demonstrations by exhibitors. The exhibitors are planning special programs from 8:30 to 9:45 on Friday morning and from 4:00 to 6:00 in the afternoon. This is a new feature in conventions and the exhibitor's committee promises some worthwhile developments.
- (4) Popular demonstrations of new scientific developments by industrial and educational leaders. Two large commercial concerns have already accepted the invitation to provide demonstrations. These demonstrations will be given in the general and sectional meetings.
- (5) Social features which will help teachers make new acquaintances and meet old friends. Receptions will be held during registration Friday morning and preceding the banquet the same evening. The Chicago teachers and the Central Association extend a most cordial welcome to all people interested in science and mathematics to attend the convention.

The business meeting will be held as usual on Saturday morning. This will be followed by a general meeting at which time a lecture demonstration will be presented. This general meeting will be followed by four group meetings, viz.: the elementary school, the junior high school, the senior high school, and the junior college. The programs for the group meetings will be a continuation of the Friday morning program but with specific application to these school levels.

The general and sectional officers believe that teachers of mathematics and science will be interested in knowing that the program for this year's convention in Chicago is planned to give teachers:

- (1) The background and principles to help them solve their most pressing problems.
- (2) A vision for the future.
- (3) Opportunity to hear the best talent obtainable. Each person invited to appear on the program is an outstanding authority.

- (4) Reasonably priced accommodations at a good hotel in a convenient location. The LaSalle Hotel has excellent convention facilities. All of the general and sectional meetings will be held in this hotel.
- (5) Programs for the general, group and sectional meetings which will be of interest and value to teachers of mathematics and science at all school levels (grades one to fourteen).
- (6) Programs which will have no duplication in the general sectional, or group meetings.
- (7) Good fellowship and hospitality by our hosts—*The Chicago Teachers*.

Now we would like to ask you this question—*Do you think you will get your money's worth if you attend this convention? Can you afford to miss it?* You can attend if you begin to plan now.

For the Officers and Chairmen of Sections of The Central Association of Science and Mathematics Teachers.

Per IRA C. DAVIS, *President*

JUNIOR AUDUBON CLUB ESSAY CONTEST

Why not win a prize? All participants in Junior Audubon Clubs of the National Association of Audubon Societies, 1775 Broadway, New York City, may take part in the 1938 Essay Contest on the subject: "Why Should We Have Bird Sanctuaries?"

All essays for the 1938 contest must be in the office of the National Association of Audubon Societies by April 15, 1938.

There are three divisions of the contest:

1. For the teachers or other organizers.
2. For boys and girls in junior and senior high school grades.
3. For children in Grades 1 to 6.

Thirty-nine prizes will be awarded. First prize in the teachers' division will consist of the Audubon Gold Medal and a two weeks' stay at the Audubon Nature Camp in Maine, plus \$25 contribution toward transportation cost.

First prize for the older children will consist of the Audubon Gold Medal, plus sight-seeing trip to New York City at the time of the Association's Annual Convention in October 1938.

First prize for the younger children will consist of the Audubon Gold Medal and \$25 cash.

Handsome prizes will be awarded to second and third place winners in all three divisions, and ten lesser prizes to other winners in each division, up to a total of 39 in all.

Full particulars of the contest may be obtained now by writing to the National Association of Audubon Societies, 1775 Broadway, New York, N. Y.

RADIUM POISONING

BY EMIL F. FRECH

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The poisonous effects of radium, both external and internal have been known practically as long as radium itself. In fact, the first case of the physiological effects of radium is that of Becquerel, who suffered a very severe burn, which was caused by carrying a tube of radium in his vest pocket. Although an external burn of this nature cannot be termed radium poisoning, yet it is the first case showing the physiological effects of the radiations of radium. Radium has the same physiological action on the external part of the body as on the internal part, namely, destruction of the tissue and cells.

The destructive action of radium is due to the fact that the radium atom is continuously undergoing a process of disintegration. During this process, three radiations (rays) are given off: namely, alpha rays, which are doubly charged helium atoms; beta rays, which are negatively charged electrons; and, gamma rays, which are high frequency radiations of high penetrating power. It is the latter, the gamma rays, which produce the results known as radium poisoning. Radium in disintegrating produces a number of other radioactive products which also disintegrate, giving off radiations, which like radium, are harmful, and the final product is lead.

The effects of radium, applied externally are well known and can be found in almost any medical text or journal. The ultimate results, however, are destruction of tissue cells, glands, and a pronounced darkening of the skin. Radium radiations set up some process in the tissues which itself ends in their destruction. The whole process is one of exaggerated stimulation of the activity of the cells of the tissues, a stimulation which varies in degrees with the degree of specialization or functional activity of the different type of cells. In its slightest degree, it is protective, but under unusual and extreme irritation the reaction becomes destructive.

During the period 1924-1929 there was brought to the attention of the public the deaths of about fifteen young girls from radium poisoning. These girls had worked for several years in watch factories, in New Jersey, applying luminous paint to watch dials. The paint used was a luminous zinc sulfide, with

a trace of copper and a minute amount of radium.

Each of the dead girls had suffered a necrosis (rotting away) of the jaw bones, which was entirely different from an ordinary infectious process or tuberculosis of the bone. They also suffered various other symptoms such as: (1) disturbances of the sex organs, (2) changes in the blood, (3) changes in metabolism (an increase in the amount of sulphur and nitrogen excreted), (4) headaches, (5) weakness, (6) undue fatigue, (7) unusual need of sleep, (8) increased excitability, fretfulness, and irritability, (9) attacks of dizziness, (10) loss of weight, and (11) anemia.

Radium, if absorbed in the body, has a preference for bone as a final point of fixation. The cause of this can be seen by studying the periodic table. From the table we can see the relationship between radium and the rest of the group II elements. Radium belongs to the same chemical group as calcium, which is the building material of the bones. When radium becomes fixed in the bones it can only do so by replacing the calcium from the bones. Radium thus becomes fixed in the skeleton. The effects are then (1) all weakly penetrating radiation would be absorbed with intense local damage, (2) the more damaging gamma rays would be, to a large extent, changed into easily absorbed secondary radiations characteristic of the calcium atom. The effectiveness of a unit of radium inside a bone would be many thousand times greater than the same amount outside the bone, and the soft tissues as well, because of the enormously greater proportion of radiations absorbed in the bone. Experimental evidence shows that there is a selective deposit of radium in bones and that the effects of the radiations emitted by radium prevents both bone growth and repair of fractures. The radiations also cause abscesses in the bone marrow.

When radioactive substances are introduced into the body death may follow a long time after, from the effects of constant irradiation of the blood forming centers. Particles of the radioactive substance are deposited in the bones, spleen, liver, and other similar organs, and produce for a period of time, seemingly curative or stimulative reactions, to be followed later by exhaustion and destruction of the blood producing centers.

The mode of introduction of the radium into the body was twofold: (1) inhalation of dust containing radioactive substances, caused by mixing the paint in the room in which the

girls worked, and (2) direct introduction into the gastro-intestinal tract, caused by tipping the paint brush with the lips, and hence swallowing a small amount of the paint from the brush.

A Commission, consisting of prominent physicians, dentists, and scientists, was appointed to study the causes, and methods of prevention of such a catastrophe as this. The recommendations of the commission were adopted and since then there have been no new cases of radium poisoning in that section of the country. Some of their recommendations were: (1) air-conditioning of the entire plant, (2) mixing of the paint in a special room, (3) pointing of brushes with water or some similar solvent, (4) cleanliness of workers, (5) wearing of regulation uniforms, and (6) various other reforms.

At the present time of writing, 23 victims of the New Jersey plants have died and there are still several who are doomed to die.

There are two other methods of acquiring radium poisoning. They are: (1) intravenous injection or introduction into the gastro-intestinal tract for therapeutic effects, and (2) drinking water, which has been activated by radium solutions, for its therapeutic effects. Today there are still physicians who are experimenting with radium solutions for therapeutic effects (especially for gout and arthritis); and radium solutions are sold by the nostrum peddler, who realizes splendid profit therefrom. A great many radium activators for the treatment of drinking water, some of which are extremely dangerous, are still sold to a gullible public.

Up to the present time there has been no satisfactory cure for radium poisoning although several have been suggested. At the present time there is considerable research being done to establish a cure. Some of those suggested are: (1) injection of rapidly oxidizing colloidal solutions, (2) exposure of the body to ultra-violet or quartz light, (3) injection of parathyroid gland hormone, (4) diet of high calcium content. It is interesting to note that any successful remedy must involve the adjustment of the calcium level by the proper calcium metabolism.

The interest in radium poisoning has recently been revived by the cases of 14 doomed women of Ottawa, Illinois, who were employees of the Radium Dial Company, and painted watch faces.

A few years ago these women were hale and hearty and now

they are awaiting their doom with no hope of cure. Fear of working with luminous paint spread through the Ottawa plant when there was news of radium poisoning suffered by girls who touched their brushes to their lips to "point" them, as they painted dials in a New Jersey plant. According to published reports, one of the women testified in a court trial that the assistant manager of the plant told them that "a different type of radium was used in Ottawa—that it was pure and not dangerous."

The girls even brought their lunches and spread them on tables on which the preparation was made up. Then one by one the girls found themselves ailing. The girls are now painfully waiting for the Illinois Industrial Commission's arbitrator to say how much money they can expect to collect from the Radium Dial Company. According to physicians, all fourteen are doomed to die, some of them soon, and some of them a slow and tortuous death.

CONSERVATION ACTIVITIES IN IOWA

On February 5, 1938, a conference was held in Des Moines to coordinate the interests and activities of various groups in the State to become active participants in conservation projects.

The conference was called by Miss Agnes Samuelson, State Superintendent of Public Instruction, and Mr. Garret G. Eppley of the National Park Service of Omaha, Nebraska.

Mr. Eppley and Mr. J. N. Darling, former chief of the Biological Survey of the United States, were the main speakers.

Among the committees appointed was a committee to select projects and activities that may be carried out by various individuals and groups of individuals during the spring and summer.

Projects from the course of study bulletin "A Guide for Teaching Science in Grades One to Eight," already in use in the schools of Iowa, will be used as a basis for the selection of projects. Projects from all organized groups in the State will be also recommended for use.

Miss Lillian Hethershaw, of the General Science Department of Drake University, was appointed Chairman of the Project Committee. Other members of the Committee are:

Professor C. W. Lantz, Iowa State Teachers College, Cedar Falls, Iowa.

Dr. W. F. Peterson, The State University of Iowa, Iowa City, Iowa.

Dr. I. E. Melhus, Iowa State College, Ames, Iowa.

Dr. George Hendrickson, Iowa State College, Ames, Iowa.

Professor H. E. Jaques, Iowa Wesleyan, Mt. Pleasant, Iowa.

Consultants for the Committee are Fred Schwab of the State Conservation Commission, Dr. D. W. Morehouse, President of Drake University, and Dr. Charles R. Keyes, Cornell College, Mt. Vernon, Iowa.

Another conference will convene again on March 12, 1938, at the Kirkwood Hotel, Des Moines, Iowa, to further the plans of the entire conference. About 75 leaders of the State are expected to be present.

HOW THE INTEREST OF PARENTS MAY BE INCREASED BY MEANS OF STUDENT PROJECTS

BY SARAH BENT RANSOM

Lambertville High School, Lambertville, N. J.

Too often the parents of a community are unaware of the true value which a public high school has for its students. They sometimes take it for granted that the education of their children is being carried out well for the best interests of each individual without an actual first-hand knowledge of their own. Some parents have openly criticized schools using unfounded facts gleaned from town gossip and have repented after irreparable damage had been done. I have observed actual cases where parents did not know until too late the courses their children were following and failing just because they could not find time to come to the school and consult with the principal and teachers. The best known remedy for all of these difficulties is a Parent-Teachers Association, but I have found a remedy which serves practically the same purpose as the formation of a society. This is the construction of student projects.

Individual and group projects are valuable in every high school course and I have found them particularly so in science. Students like to be asked to accept responsibility and enjoy being commended on good work. Each person has an opportunity to express himself and to prove what he can accomplish in making something either useful or spectacular. Each student learns to reason and observe for himself, develops initiative, gains practical experience, and often is helped in discovering the occupation in life for which he is best fitted. During two years of teaching I have organized projects to accomplish these very ends in chemistry, physics, and biology classes, as well as in the science club. Often teachers think that individual work such as I have described takes too much time from the regular curriculum and that the prescribed courses of study cannot be completed. I have found these criticisms to be untrue provided that the projects are carried out correctly.

In the fall of the year I explained to every class and to the science club that I would like to have as many students as possible make exhibits which would depict some phase of their work during the year, or any interesting and useful scientific

projects which they found particularly absorbing. I told them that the best ones would be entered in the Childrens' State Science Fair to be held at the Newark Museum in April, and that all would be shown to their parents at our school science exhibit in June. I spoke of the prizes we had won at the Science Fair the year before. With these goals in mind nearly every child decided to make something.

For a week at noon hour and after school I had conferences with students. Some of their ideas would not work out at all, but after various suggestions and reference work the students agreed upon what they wanted to construct. Groups were arranged according to the different abilities of the members, and the division of labor was worked out so that each person performed those duties for which he was best qualified and which he most enjoyed. A large, complicated project could have the members of the group divided to work on the following parts: 1. Sign Printing; 2. Carpentry; 3. Sewing; 4. Scenery Painting; 5. Drawing; 6. Electrical Work; 7. Obtaining of Material; 8. Correspondence. I found that if at first the students were doubtful about the congeniality of their group all that feeling disappeared soon after they began the actual work. They were really glad they had shared the responsibilities after they did discover what a great amount of work was involved.

Each week a report of accomplishment and an actual view of the progress was given to me. The students were not taken from any classes or kept from any other required activity to work on the exhibits. Time was not taken from science classes for this so that the necessary course of study was carried out completely. The eighth period, forty-five minutes long, noon hour, and after school for the town pupils, were appointed times for conferences and actual construction. About three-fourths of the work was done at school and the rest was done at home during the leisure time of the students. If this sort of a plan is followed throughout the year there is no rush or confusion during the week preceding the date of the school exhibit.

The photographs show some of the projects which were made this year. They were all placed in the mechanical drawing room on table tops about three feet square. The blackboards and walls served as supports for the background and signs which explained each exhibit. There were about twenty projects which covered phenomena, facts, and principles involved in chemistry, physics, biology, and general science. The remainder of avail-

able space was taken up with notebooks, leaf collections, plaster models, drawings, photographs, a bird collection, and set-ups of interesting laboratory apparatus.

Some of the most interesting and practical exhibits were "Magnetic Force," "The Density of Liquids," "Conductivity of Metals," "Common Wood of New Jersey," and "Conductivity of Solutions." Four exhibits which have not been mentioned above were given awards at the Science Fair. The awards were first, second and third prizes in the classification Physics and

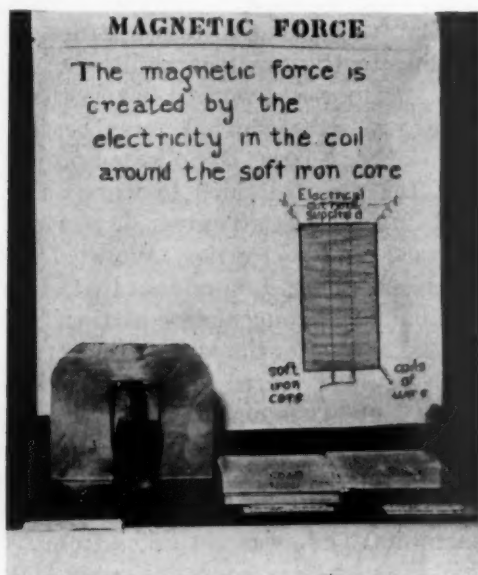


FIG. 1. Magnetic Force.

Chemistry Group Exhibits from High Schools, and also the first prize in the classification Physical Geography.

"Magnetic Force" was made by one boy in the senior class who had taken both Physics and Chemistry. He constructed an electromagnet by winding coils around two pieces of soft iron and connecting the wires to a transformer. The photograph does not show very clearly the box of iron filings, but this was placed directly below the magnet. To operate this, the observer was directed to push the lever and the button located at the end of the lever. This made the current flow and at the same time lifted the box near the magnet. The iron filings were attracted to the magnet and the flux lines were very definitely

shown between the two terminals. When the bar was allowed to fall back to its original position the current was shut off and the iron filings dropped back into the box. The large drawing in the background showed the way the coils were wound and explained the principle. To the right of this apparatus were two frames which showed the lines of force around a permanent bar and horseshoe magnet which had iron filings sprinkled on top of them. The whole exhibit was black and white and this made the arrangement effective. I have used this exhibit as well as

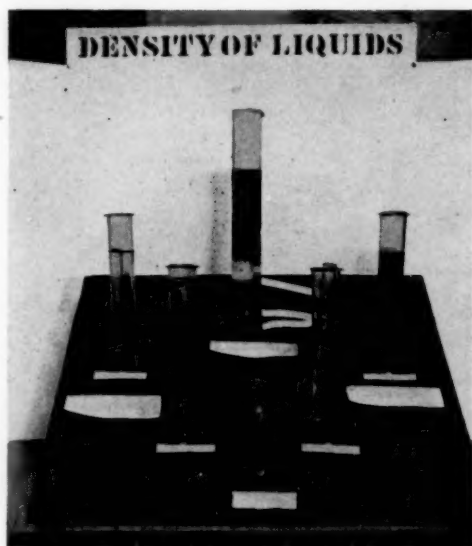


FIG. 2. The Density of Liquids.

most of the others for visual aids in teaching classes. Students are much more interested in apparatus made at school than in that purchased from a supply company.

"The Density of Liquids" showed that the mass per unit volume of different substances varies enough to allow them to be supported one upon the other without mixing. The large graduated cylinder in the center had mercury with a density of 13.6 grams per cubic centimeter supporting an equal volume of carbon tetra-chloride, copper sulfate, machine oil, and alcohol. Alcohol had the least density and could be supported by the oil which in turn was supported by copper sulfate, etc. The small cylinders contained hydrometers from which the density of each liquid could be read. Besides being very instructive,

this project was very striking because of the various colors of the liquids used. The people who came to the school exhibit and who had never before thought about this property of liquids were interested to study it.

The exhibit, "Conductivity of Solutions," was done by a group of five members. The box was built of plywood reinforced with pine. Six holes were cut to fit glasses which held liquids with varying degrees of ionization. Two copper electrodes fit into each glass and they were connected to hand made switches

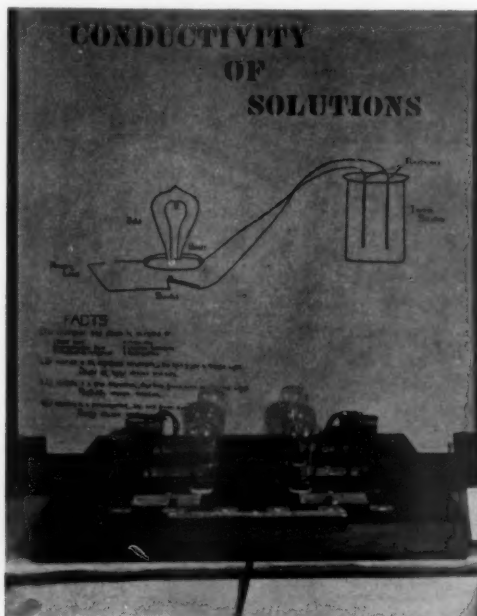


FIG. 3. Conductivity of Solutions.

at the front of the box. A clear bulb with a carbon filament was connected directly to each pair of electrodes so that the comparative ability of the solutions to conduct electricity could be determined by the intensity of the light produced when the switches were closed. The exhibit proved that dilute solutions are better conductors of electricity than concentrated, and hence the dilute solutions are the more highly ionized. The substances used in this were: (1) Acetic acid, very slightly ionized; (2) Dilute hydrochloric acid, very highly ionized; (3) Concentrated sulfuric acid, a fairly poor conductor; (4) Solution of NaCl, well ionized even in concentrated state; (5) Cal-

cium hydroxide, a fair conductor; (6) 25% solution of NH_4OH , a good conductor. A large diagram, labels, and cardboard signs explained the result obtained by pushing each button. The construction of this exhibit was very carefully done without any outside assistance.

"The Conductivity of Metals" pointed out that the ability of a wire to conduct electricity depends upon the cross sectional area, the length, and the material of which it is made. Lengths of four wires each of a different material were obtained and cut

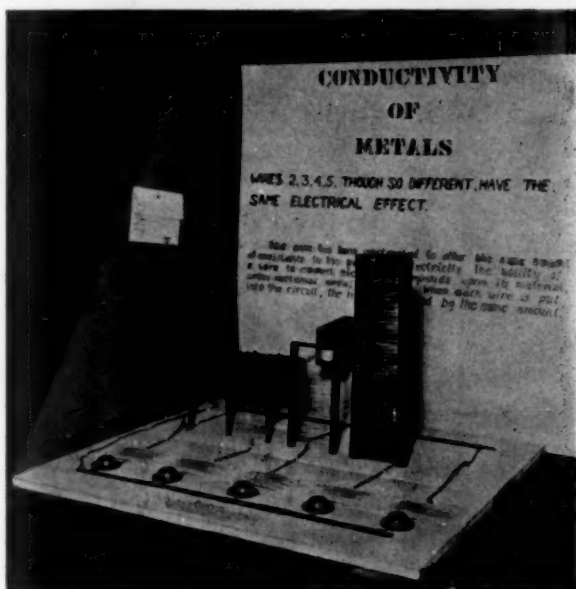


FIG. 4. Conductivity of Metals.

to represent 4.5 ohms resistance. The materials used were two copper wires of different cross-sectional area, some iron wire, and manganin. The photograph shows how the wires were wound around poles and each connected to a push button. Each connection terminated at a flashlight bulb, supplied with current from two dry batteries. The bulb burned with the same degree of intensity for each wire, because even though they were of different lengths, they had the same resistance. One copper wire of large cross-sectional area which offered practically no resistance to the flow of electricity was used as a check on the others and naturally the light burned very brightly when the current flowed through it. The principles involved in

the project are often difficult to prove to a class because it takes so much time to get the apparatus together. I have used and kept the entire thing as a part of our physics equipment.

The last exhibit which I mentioned as being interesting was "Common Wood of New Jersey." A boy who lives on a farm collected samples of wood from the various trees nearby. He was very patient and careful to get pieces of the same diameter



FIG. 5. Common Wood of New Jersey.

and length and which showed the grain distinctly. He sawed each sample to show the grain tangentially and cross-sectionally, and left the bark on the remainder. The pieces were varnished and mounted to a piece of ply board three feet square. Labels were placed under the samples and the title was made from small twigs nailed to the top of the board. A notebook was made which explained the habitat, fruit, and leaves of each tree. There were twenty-four samples in all, and the boy has collected others from which he plans to make an exhibit for next year of at least one hundred specimens.

Parents show a definite interest in work of this kind done by their children. They hear the children talk over plans and are anxious to see the finished product and to compare it with things made by others. I have become acquainted during the year with parents who have gone out of their way to talk to me about "the project Johnnie is making." I would never have met them in any other way. Some parents have offered to drive cars to help transport the exhibits to the Science Fair and others have been interested enough to donate materials which we otherwise would have had to buy. One mother told me how grateful she was that her boy had been allowed to work with a certain group of children. He had always been bashful and not very popular until he proved his great ability in electrical construction and lathe work. He is now in an engineering school and is making out very well.

Student projects allow any teacher to become better acquainted with individuals. The student shows plainly a genuine interest in his work, and is more willing to apply himself in class. Any subject taught directly from a textbook is dull, and lacks stimulation to the eagerness of the student. Parents, teachers, and students can see actual results if exhibits are made throughout the year, and all have an opportunity to work together for the best interests and welfare of the community.

DIAMOND RUSH TO CALIFORNIA NOT JUSTIFIED BY CHEROKEE FLATS FINDS

"Recent diamond finds at Cherokee Flats, near Camino, Calif., do not justify any rush to the area in search of easily-gotten glittering stones," says Dr. R. A. Foshag, curator of minerals at the National Museum. "We receive at the museum one diamond from the Cherokee Flats region every three or four years. Perhaps two hundred diamonds have been found in California since the gold rush days, the largest reported being about seven carats."

The Cherokee Flats diamonds, explains Dr. Foshag, are perfectly good stones, their rarity, rather than any defect in them, making the placer gold deposits unprofitable as diamond mines. Near the creeks is a dike of serpentine rock from which the diamonds are believed to have been freed by weathering during many thousands of years. Working this dike for diamonds would cost much more in labor than it could ever produce in diamonds, he believes.

Diamonds are commercially produced from a mine in Arkansas, and have been found in glacial drift in sizes up to 20 carats in a number of states, among them being Wisconsin, Illinois, and Kentucky. Reported diamonds from other states often turn out to be other, less-valuable stones, such as sapphires or quartz crystals.

THE DETERMINATION OF SEX

BY D. CECIL RIFE

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When is the sex of an individual determined? What are the determining factors, and is it possible for man to consciously play a part in determining the sex of his own offspring? Probably more books have been written, and more fantastic theories evolved to be later disproven, on sex determination than on any other single phase of biology. Newspapers sporadically announce that someone has found a means of causing the unborn child to develop into whichever sex desired. What do modern biologists have to say on the subject?

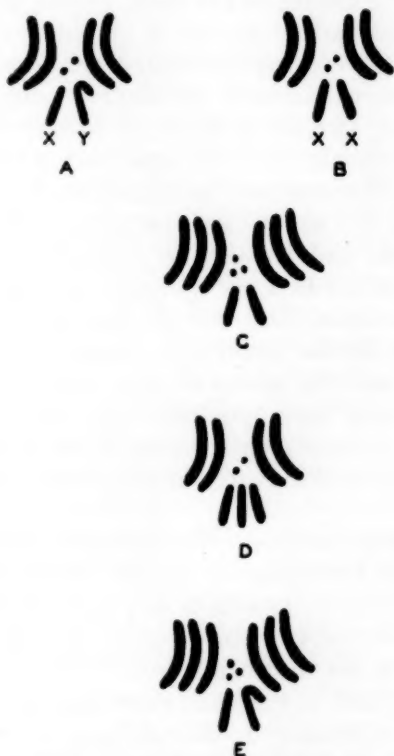
The sex of the individual is, under normal circumstances, determined at the time of fertilization of the egg. If we examine cells under the microscope at the time of their division, we find the central or nuclear portion to contain long, and as a rule, slender bodies, which readily take on a stain. These structures are known as chromosomes, and are present in all plant and animal cells. Furthermore, with the exception of the germ cells, the chromosomes occur in pairs, the members of a pair being so similar that they are indistinguishable. The germ cells, however, contain only one member of each pair, thus the number of chromosomes in the germ cells is half that of the other cells of the organism. When the sperm and egg unite to form a new one celled individual, the chromosomes are again paired.

In animals, and even in some plants in which the sexes are separate, we usually find one kind of chromosome which, while occurring in pairs in females, occurs singly in males. These are known as X chromosomes, and in males are usually accompanied by an odd shaped chromosome designated as Y.

As only one member of each pair of chromosomes is present in the germ cells, half of the sperms contain an X, and half a Y chromosome, whereas all eggs contain an X chromosome. Thus the chances are equal whether an egg will be fertilized by a sperm containing an X or one containing a Y chromosome. Under ordinary circumstances, if an X containing sperm fertilizes an egg, the new individual will be a female, whereas if a Y containing sperm fertilizes the egg it will be male. In man there are twenty-four pairs of chromosomes, including X and

Y. Each cell in the body of a woman contains two X chromosomes (exclusive of the germ cells), whereas each cell in the body of a man contains an X and a Y chromosome.

Genes, or hereditary factors, are carried within the chromosomes. Those carried by the X chromosome are termed "sex-linked." Over two hundred sex-linked genes have been mapped in the fruit fly, and many have been discovered in other organisms. In man more than a score of sex-linked factors are known,



Diagrammatic representation of the chromosomes of the various sex types of the fruitfly, *Drosophila melanogaster*. A, normal male; B, normal female; C, inter-sex; D, super-female; E, super-male.

one of the commonest being the one responsible for red-green colorblindness. As there is only one X chromosome present in males, the hereditary behavior of sex-linked traits is somewhat different from that of traits due to factors carried on the other chromosomes. For example, a man cannot transmit colorblind-

ness to his son, because the son receives the X chromosome from his mother. A woman may transmit colorblindness, but not be colorblind herself, as she has two X chromosomes, and one of them may carry a factor for normal color vision. A colorblind woman always has a colorblind father and a mother who is a carrier of the condition. As would be expected, colorblindness occurs much more frequently in men than in women. Hemophilia, optic atrophy and the total absence of sweat glands are among the sex-linked traits known in man. No genes are known to be carried by the Y chromosome in man, and only a few by the Y chromosome in other organisms.

There are some variations in the manner in which the chromosomes concerned with sex occur in various species. Mammals, fish and insects usually have the same sort of situation as man, that is, two X chromosomes in females and an X and a Y in males. In birds, the situation is reversed, males possessing the paired condition, and females the unpaired condition of one type of chromosome. In a few species of insects and birds there is no Y chromosome, thus one sex has one less chromosome than the other. In the honey bee, females possess thirty-two chromosomes, and the males sixteen unpaired chromosomes, females developing from fertilized eggs, and males from unfertilized eggs. Certain plants, in which the sexes are separate, show corresponding differences in the chromosomes of the two sexes.

The association between chromosomes and sex has been known since the beginning of the century, but numerous instances of sex reversal, especially in plants, have left doubts as to the infallibility of chromosomes as the sole agency in the determination of sex. For example, in hemp, a plant in which normally about half of the plants are male and half female, it is possible by increasing or shortening the length of day, to produce all males or all female plants at will. A noted botanist has succeeded in producing identical twin plants (two plants arising from the same bulb) of opposite sexes in the jack-in-the-pulpit, a plant in which the sexes are separate. This was accomplished by growing one plant in rich, and the other in poor soil.

A few extremely interesting cases of sex reversal in animals are known. Crew, a noted geneticist, has recorded the following instance. A hen, a good layer and the mother of chicks, at the age of three and one half years assumed the appearance, be-

havior and voice of a male bird, and later became the father of chickens. A post-mortem revealed that the ovary (in birds there is only one functional ovary), had atrophied due to tuberculosis. The ovary, when functional, produces hormones which inhibit the formation of male sex organs, but in the absence of the hormone, male organs developed. Another investigator, Riddle, has increased the percentage of female pigeons hatched, by forcing egg production. How are these instances of sex reversal to be reconciled with the chromosome theory of sex determination?

Experiments with the fruitfly, the old standby of the geneticist, shed light on the problem. As in man, the female fruitfly normally possesses two X chromosomes, and the male an X and a Y. Due to irregularities in cell division in a certain strain, it was possible by certain breeding procedures to produce individuals with peculiar combinations of X and Y chromosomes, along with the other pairs. Some individuals had a pair of X chromosomes, but with the other chromosomes in sets of three. These flies showed a combination of male and female parts, and were called inter-sexes. The reverse situation was obtained in the chromosomes of other flies, that is, three X chromosomes and the rest in pairs. In these the characteristics of a female were accentuated, and they were designated as super-females. Still others were produced with an X and a Y, and the other chromosomes in sets of three. In these the male characteristics were exaggerated, and they were known as super-males. In flies in which all of the chromosomes, including the X, were in sets of three, or in sets of four, the sex of the individual was that of a normal female. In individuals possessing paired chromosomes, including two X, but with a Y in addition, the sex was that of a normal female. Thus the ratio of the X chromosomes to the other chromosomes, aside from the Y chromosomes, is apparently the deciding factor in the sex of the fruitfly. The production of inter-sexes, super-males and super-females clearly shows that sex is quantitative. Genes within the chromosomes, rather than the chromosomes as a whole, normally determine the sex of the individual. In the fruitfly, the X chromosome apparently carries a preponderance of factors for femaleness, and the other chromosomes a preponderance of factors for maleness.

In vertebrate animals, including man, males, on the average, have a higher metabolic rate (rate of oxygen consumption) than

females. Possibly the sex of the individual in such animals is due indirectly to genes which determine metabolic rate. If this is the case, the majority of genes tending to decrease metabolic rate must be located on the X chromosomes, and the majority of these tending to increase metabolic rate located on the other chromosomes.

In plants we find much evidence of the quantitative nature



Left: single flowered zinnia containing both male and female parts. Right: double or dahlia flowered zinnia, containing many petals and female parts, but no male parts.

of sex. In the composite family, of which daisies, sunflowers, and zinnias are examples, we typically find a head with many small florets in the center, surrounded by a circle of petals. The central florets contain both male and female parts, whereas each petal is associated with a female flower. Completely dahlia or double flowered zinnias, however, have no central florets, but are composed entirely of female flowers, each associated with a petal. Old fashioned zinnias, on the other hand, have

only a single outer row of petals, and a central region composed of florets containing both male and female parts. Dahlia flowered zinnias are recent developments, brought about by gene mutations. Various degrees of intermediacy are encountered. Similar situations exist in a number of flowering plants. In the dandelion the flower is composed entirely of female parts and petals. Contrary to the usual situation in plants and animals, the egg cells contain the chromosomes in pairs rather than singly, and, as they are not fertilized, the number of chromosomes remains constant.

In higher animals, the sexes are, as a rule, separate, and evidence of their quantitative nature is not so apparent. The primary characteristic of a male is the ability to produce sperms or pollen, and of a female the ability to produce ova or eggs. Organisms which combine both functions in a single individual are known as hermaphrodites, and such a situation is very common in plants, and frequently found in lower animals.

In man, no authentic cases of true hermaphrodites are on record, although there are instances of men possessing rudimentary female reproductive organs, and also of the reverse situation. There are a number of secondary sexual characteristics, such as the plumage of birds, and general conformation in animals which show quantitative variations. Such characteristics are due to hormones secreted by the sex organs. Removal of the testes or ovaries of immature birds and animals show a marked effect in the expression of secondary sexual characteristics in the mature individual. Voice, hairiness of the face and general body conformation show considerable sexual variation in man. A little reflection shows that some men are more masculine than others, and that women show corresponding variations in secondary sexual traits, indicative of the quantitative nature of sex.

A great many observers, while admitting the usual association of chromosomes with sex, believe that in human beings other factors play a part. They cite cases where families are composed of children of all one sex, or preponderantly so, whereas if the chromosomes are the sole agency in the determination of sex, the chances of a child being a boy or a girl should be equal. While this is true, it must be remembered that on a pure chance basis we should occasionally find such families. For example, in families of five children, we should expect one in thirty-two of such families to be all girls, and one

to be all boys. We recently conducted a survey in a city of several thousand population to determine whether or not the distribution of sex ratios within families is what one should expect on a chance basis. An amazing agreement was found between the predicted and the actual figures. Thus there is no basis for assuming that factors other than the chance meeting of egg and sperm played a part in determining the sex in the population investigated, which, we believe, is a fair sample of the general population.

This, of course, does not necessarily imply that man may not some time devise a means for determining the sex of his own progeny. While man is a highly integrated organism, and is more independent of his environment than plants and lower animals, yet it is conceivable that some means may be devised for affecting metabolism and physiological processes during early embryonic development so as to cause the individual to develop into the sex desired, or, possibly a way may be discovered for destroying all sperms containing either X chromosomes or Y chromosomes at will. Either method would enable man to consciously play a part in determining the sex of his own offspring.

CO-ORDINATION OF ELEMENTARY ARITHMETIC TEACHING WITH THE METHODS OF HIGH SCHOOL MATHEMATICS

BY P. H. NYGAARD

North Central High School, Spokane, Wash.

As a high school mathematics teacher the writer has had an opportunity of observing and analyzing the difficulties of high school freshmen. An attempt will be made in this paper to point out how the instructional methods used in grade school arithmetic might be modified so that pupils can make the transition to high school mathematics with less difficulty.

Teachers and textbook writers of elementary school arithmetic feel that what is taught in later mathematics is of little concern to them. It is true that elementary school pupils need methods different from those suitable in high school classes. There is room, however, for better co-ordination. Since nearly all elementary school graduates enroll in high school, it would seem that more consideration should be given in the arithmetic

curriculum to the methods employed in high school mathematics and science.

The first comment will be directed at the arrangement used by pupils in writing their solutions of verbal, or thought, problems. Take this problem: Find the cost at \$125 per acre of a rectangular piece of land 85 rods by 64 rods. Altogether too many textbooks, teachers, and pupils use solution A.

85	<u>34</u>	125	
<u>64</u>	160)5440	<u>34</u>	
340	<u>480</u>	500	
<u>510</u>	640	<u>375</u>	
5440	<u>640</u>	\$4250 cost	A

Pupils who rely on solution A have no scruples about letting parts of their scribbling overlap. They do each step wherever they find a spot of vacant paper, so that the final step is often buried somewhere in the middle of the solution. They get the answer, perhaps, and that is all there is to it. It is here suggested that all written solutions should be arranged as in B.

$85 \times 64 = 5,440$ sq. rods	
$5,440 \div 160 = 34$ acres	B
$34 \times 125 = \$4,250$, cost	

The pupils can do their figuring on "scratch" paper, or, better yet, have solution B on the left side of their paper and A in a space ruled off to the right for that purpose.

It may be argued that solution A, without B, is the natural way, by which is meant that it is the method which anyone would use if he had an actual problem of this kind to do. It is also obviously more economical of time and paper, because the figuring must be done somewhere else when B is used. Our teaching, however, should involve more than just following the line of least resistance. Mathematics requires, and should be taught so as to develop, habits of logical thinking, orderliness, and conciseness of expression. There may be some doubt as to the carry over of these habits into other fields, but they surely will not carry over if they are not encouraged in mathematics itself. That these habits are emphasized by solution B cannot be denied.

The chief reason for the consistent use of arrangement B is that it fits in very nicely with the solution of equations in algebra and with the formula methods used throughout mathematics and science. Pupils who have learned only method A insist on doing their algebra something like this:

$$\begin{array}{r} 15x + 13x = 84 \\ \underline{15} \qquad \underline{3} \\ 28x = 28 \quad 84 \\ \underline{84} \end{array}$$

For such monstrosities they cannot be blamed, if they have been allowed unchallenged to use these haphazard methods in their arithmetic work. The placing of successive equation-like statements under each other is such a prevalent mathematical form that elementary arithmetic teachers cannot afford to ignore it.

Our second suggestion deals with the methods used in adding or subtracting fractions. Most elementary arithmetic teachers and textbook writers arrange the fractions in a column. Method C is often encountered.

$$\begin{array}{r} \frac{2}{3} + \frac{1}{5} \\ \hline \frac{10}{15} + \frac{3}{15} \\ \hline \frac{13}{15} \end{array} \quad \text{C}$$

This may be a quick way of arriving at the answer, but it is hard to conceive how a pupil using it can understand that he is really changing fractions to other equivalent fractions. Then, too, the common denominator is placed at the top, just the opposite from its correct position. Method D is much better.

$$\begin{array}{r} \frac{2}{3} + \frac{1}{5} \\ \hline \frac{10}{15} + \frac{3}{15} \\ \hline \frac{13}{15} \end{array} \quad \text{D}$$

Nevertheless, there is one objection to both of these, namely

their inconsistency with the arrangement used for multiplying and dividing fractions. These latter problems are universally written as $\frac{2}{3} \times \frac{1}{5}$ and $\frac{2}{3} \div \frac{1}{5}$,—that is in the form of horizontal statements. Hence it would seem that a similar arrangement should be used for adding or subtracting fractions, such as method E.

$$\begin{array}{r} \frac{2}{3} + \frac{1}{5} = \\ \frac{10}{15} + \frac{3}{15} = \frac{13}{15} \end{array} \quad \text{E}$$

This method would obviate the need of learning special forms for such problems and would at the same time make the logic underlying the process easily understood.

The main point in favor of method E is that pupils who use it will have nothing to unlearn when they come to algebra. No teachers of algebra would allow pupils to add literal fractions by either method C or D. Solutions like E are demanded,—for instance

$$\begin{array}{r} \frac{a+2}{5} + \frac{a-3}{7} = \\ \frac{7a+14}{35} + \frac{5a-15}{35} = \frac{12a-1}{35} \end{array}$$

Pupils who are not already familiar with this method from their elementary arithmetic problems can, of course, learn it in the high school, but most of them spend a great deal of precious time floundering around with a mixture of C or D and E. It seems, therefore, that the horizontal arrangement of problems in adding or subtracting fractions should be adopted for exclusive use in the grades.

The third difficulty to which we shall refer relates to division problems. It is usual in elementary arithmetic to use the expression, "goes into," when one number is to be divided by another. Instead of "6 divided by 2," the problem is stated as "2 goes into 6." When long division is encountered, the problem of dividing 168 by 14 is written $14 \overline{)168}$, and is often read, "14 goes into 168." Many pupils get the idea that the long division sign, $\overline{)}$, means "goes into." Notice carefully that when the "goes into" method is used the divisor is stated first and the dividend second. So far, so good; the trouble begins

when fractions are to be divided. Such problems are always stated and written as $\frac{2}{3} \div 8/9$. When this form is used, the dividend is placed first and the divisor second. It is necessary to invert the divisor, and hence it is important that the pupils be certain as to which is the divisor. How can they be expected to be sure of this, when all their other division problems have been stated with the divisor first? Is it any wonder that they revert to their previous mental associations and invert the dividend?

It is our contention that division problems should be stated from the beginning so that the dividend comes first. The phrase, "goes into," could well be eliminated from the arithmetic teacher's vocabulary. Oral forms such as: "6 contains 2 how many times?", "6 is how many times 2?", or "6 divided by 2 gives what?", should be used. The written form, $6 \div 2 = 3$, should be emphasized. When the long division sign is used, such as in $14 \overline{)168}$, the problem should be read "168 divided by 14," and it would be psychologically important to write first 168, then the sign, and lastly 14. If these suggestions are consistently followed, the division of fractions should give little trouble.

In advanced mathematics, division is indicated by a dash and two dots or by the fraction method. In both of these the dividend comes first. Mathematics has no sign or symbol for "goes into." High school pupils whose ideas on division are based on the "goes into" habit are lost. The algebra teacher tells them: "The problem is x divided by y ." To this they retort, audibly or mentally: "Is it x into y or y into x ?" Much of this befuddling would disappear if the grade schools stressed that division means the dividend divided by the divisor.

The last point to be considered will be the introduction of algebra, usually the solving of simple equations, in the upper elementary grades. Two arguments are advanced in favor of this,—first, that pupils who have had this start in algebra will get along better in their high school mathematics, and, secondly, that it is wise to bring in something new to relieve the monotony of years of arithmetic.

The first of these arguments is usually invalid. Instead of being helped in high school by the knowledge of algebra they gained in the grades, the pupils who have had such preliminary training are more often handicapped. Many grade school teachers who include algebra in their arithmetic classes are not well grounded in the fundamental ideas of mathematics. Fur-

thermore, the algebra is frequently thrown in only as a make-shift. Even if the elementary school algebra is efficiently handled, the net results are not likely to be beneficial to the pupils. The sequence of topics, the methods, and the textbook used in the high school course will very likely be different from those used in the grades. For instance, the high school teacher who wishes to postpone transposing of terms in the solution of equations until the pupils have a clear conception of the principles involved, is often thwarted by pupils who have had this mystic secret revealed to them in their arithmetic classes. Such pupils are as a rule reluctant, even stubborn, about changing their methods. Similar conflicts occur in regard to the use of negative numbers. If the pupils enter their freshman mathematics without having had a heterogeneous preliminary study of algebra, it is much easier for the high school teacher to give them a good start in the subject.

The second argument mentioned above is sound, provided the elementary schools concerned are giving their pupils a thorough training in arithmetic. If arithmetic is being skipped in the lower grades and skimmed in the others, a little monotony would be better than variety. The enrichment of arithmetic in the upper grades can be effected to better advantage by other topics than algebra,—such as, experience in making actual measurements together with a clear knowledge of the inaccuracies of measured results; practice in rounding off numbers to two or three significant figures; statistical work dealing with averages, medians, and graphs; and a good introduction to the metric system, which is becoming more and more important in this country. These topics can be studied in the arithmetic classes without any break in the continuity of the work, such as occurs when algebra is introduced, and they are of direct value to the pupils in their later mathematics, science, and everyday life affairs.

The four proposals here made by which better co-ordination of grade school arithmetic with high school mathematics and science might be achieved, are not intended to constitute an exhaustive study of the subject. It is hoped, however, that the presentation will be sufficiently challenging to produce some thinking along the lines suggested.

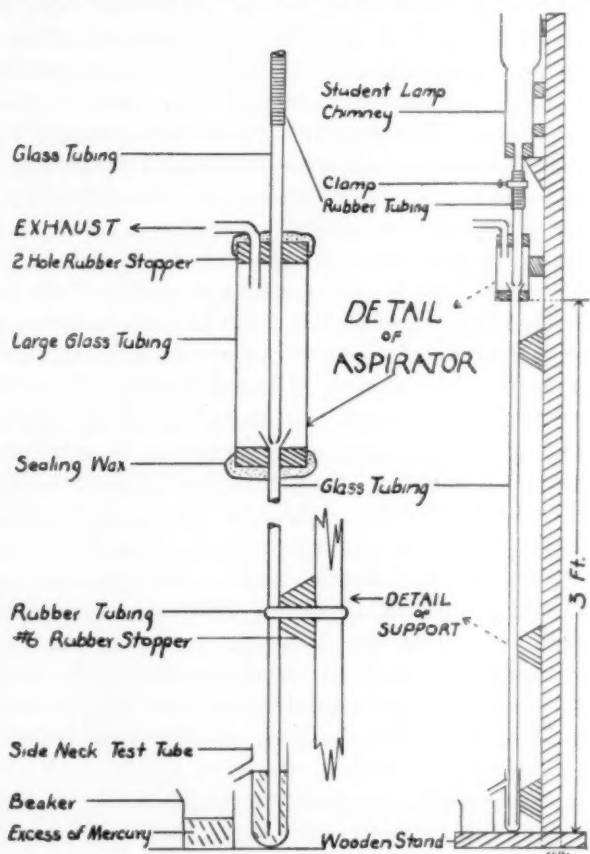
*When you change address be sure to notify Business Manager
W. F. Roecker, 3319 N. 14th Street, Milwaukee, Wis.*

A MERCURY VACUUM PUMP

BY W. T. WILKS

Tallassee Public Schools, Tallassee, Ala.

Science teachers are always on the alert for construction projects that are worth-while from the student's standpoint. If the project is one that can be carried out with little or no teacher supervision, and at the same time can provide the



laboratory with a useful piece of equipment, it is especially valuable. The following project seems to meet all of the preceding specifications.

The Mercury Vacuum Pump can be constructed from the accompanying drawing with very little effort, and from materials that are available in most science laboratories. It will pro-

vide a vacuum sufficiently low for all common experiments in physics and general science.

The vacuum pump may be used as a substitute for the expensive pump purchased from supply companies, it may be used by individual pupils to supplement work with the more efficient pump, or it may be used to demonstrate the principle of the mercury vacuum pump. The pump is especially useful for the latter purpose, as its construction resembles the outline of the pump as shown in many elementary physics and general science texts.

Suggestions: Ordinary laboratory glass tubing is used.

If no large glass tubing is available for the aspirator, a test tube or vial with the end filed off is a satisfactory substitute. The glass tubes in which photographic developing powders are packed also may be used for this purpose.

If large glass tubing is available, it may be substituted for the student lamp chimney. Glass tubing used for this purpose should have a diameter of not less than one inch.

The neck of a distillation flask, filed off, is an excellent substitute for the side arm test tube used in the apparatus.

A short section of rubber tubing placed over the arm of the side arm test tube will prevent splattering of the mercury as it flows into the beaker.

Regular vacuum rubber tubing must be used. Ordinary laboratory tubing will collapse as the vacuum is formed inside.

The height of the apparatus may vary, provided the aspirator is at least three feet from the floor.

To operate the Pump: Connect the container to be exhausted to EXHAUST by means of vacuum tubing. Close the clamp below the student lamp chimney and fill the chimney partly full of mercury. Open the clamp slowly and allow the mercury to flow through the aspirator. When the mercury is near the bottom of the chimney close the clamp and pour the mercury from the beaker back into the chimney. Repeat the operation. Several operations are necessary to secure a high vacuum.

SALARIES

... A study made by Professor Harold F. Clark of Columbia reveals that the public school teacher has drawn an average salary of \$1,350 in the years from 1920 to 1936. For doctors the average has been \$4,850; lawyers, \$4,730; and regular college teachers, \$3,050. Draw your own conclusions!—*The American Teacher*.

CARTOGRAPHICAL PROJECTIONS FOR GEOGRAPHICAL MAPS

BY ALEXIS M. UZEFOVICH, Sc.D.

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Introduction. The network of reference lines on a map representing the meridians of longitude and the parallels of latitude is a cartographical, or map projection. These lines whether drawn straight, curved or both, determine the type of map projection.¹

The scale along selected meridians or parallels is made the same as the scale used for decreasing the earth's radius.² This is the basic unit dimension of a projection and is the *principal scale*. In other directions the *local scales* are smaller or larger than the principal scale. The smaller the difference between the principal and any local scale the more perfect is the projection.

CLASSIFICATION OF PROJECTIONS

By their properties, projections are divided into three groups:

1. *Conformal*, or *Orthomorphic* projections, (equiangular and true-shape for small areas). Small areas on the map are similar in outline to the originals on the earth's surface, but large areas are not correctly represented. The angles in any small figure are preserved unaltered, and the meridians and the parallels intersect at right angles. The scale on conformal projections around any point in its immediate neighborhood is the same in all directions (not necessarily correct) and varies from point to point.

2. *Equal-area*, or *Homolographic* projections, (equivalent or true-surface). Equal areas on the map are equal areas in reality, i.e. the countries represented retain their relative sizes. The meridians and the parallels intersect at right angles on some equal-area projections, on others, only the central meridian cuts parallels at the right angle. The scale on equal-area projections is correct only along certain lines.

3. Other projections, *neither conformal nor equal-area*.

Some projections of these groups may possess other properties: rhumb line—a straight line, (Mercator); true azimuths

¹ It is desirable to include the study of map projections in the school program to prevent students of geography from committing the common error of measuring areas on a non-equal area projection or taking bearings from a non-azimuthal projection.

² Projections for any atlas map are developed from the dimensions of a globe on a given scale and taking the earth as a sphere instead of a spheroid.

from one or two given points; true distances from one or two given points; great circles—straight lines (Gnomonic); great and small circles on the earth—circles on the projection (Stereographic).

No Projection can be both conformal and equal-area. This would give an unattainable correct representation of the earth's spherical surface which cannot be flattened into a plane without stretching or tearing. The representation of the geographical features on a map for a large area such as a continent is an approximation.

By methods of construction projections are classified into the following groups:

1. *Perspective* projections. The earth's surface is represented on a plane as it would be seen in perspective; *Orthographic* projection, if the point of view is infinitely distant from the earth; *Stereographic* projection, if the point of view is on the earth's surface; *Gnomonic* projection, if the point of view is in the center of the earth.³

2. *Zenithal*, or *Azimuthal* projections, in which the surface of the earth is transferred on the tangent plane at a chosen point.

3. *Cylindrical* projections, in which the surface of the earth is transferred on the surface of a tangent or secant cylinder, and this cylinder is cut from base to base and rolled out into a plane.

4. *Conical* projections, in which the surface of the earth is transferred on the surface of a tangent or secant cone (conical projections with one and two standard parallels), and this cone is cut from the apex to the base and rolled out into a plane.

5. *Conventional* projections, which are arranged arbitrarily.

Theoretically, there is no limit to projections that might be invented. As a matter of fact, a large number have been introduced, but few are actually used in geographical atlases and for school wall maps.

MAP PROJECTIONS FREQUENTLY USED

World Maps are represented on Mercator's cylindrical conformal projection, on the equal-area projections of Mollweide and Aitoff, and sometimes on Lambert's cylindrical equal-area projection, on Van der Grinten's projection (neither conformal

³ The Perspective projections are the oldest ones. The Gnomonic projection invented by the Greek philosopher Thales (639-548 B.C.); the Orthographic projection by Apollonius, Greek geometer (247-205 B.C.) and the Stereographic projection by Hipparchus, Greek astronomer (180-125 B.C.).

nor equal-area) and on the interrupted equal-area projections of Goode, Johnson, Boggs and Deetz.

Mercator's Cylindrical Conformal Projection. (Mercator, 1512-1594, Dutch cartographer.) This projection is widely known, being used in atlases to represent the world, although not intended for geographical purposes.⁴ Mercator's projection creates a wrong impression of the relative dimensions of the earth's surface. For instance, Greenland appears larger than South America, whereas it is only about one-ninth as large.

The meridians are equidistant vertical straight lines and the parallels are horizontal straight lines, the intervals between them increasing as they recede from the equator. The spacing of parallels is so arranged that at any point of intersection of a meridian and a parallel the scale is the same in all directions (true in practice on any very small area), i.e. the projection is conformal.

The scale is equal to the principal scale only along the equator. On the parallels and meridians the scales become larger than the principal scale as the latitude increases; hence the areas and distances are greatly distorted in higher latitudes (Fig. 1).

Mollweide's Equal-Area Projection. (Mollweide, 1774-1825, German mathematician.) This projection is an ellipse with the equator as the major axis which is twice the minor axis in length and with an area equal to the earth's surface on a given scale. All parallels are straight lines spaced closer towards the poles. The meridians, equally spaced on the parallels, are curved lines (semi-ellipses), except the central meridian which is a straight line, and the 90° meridians form a circle. Areas between two neighboring parallels are equal to the surface of spherical belts and equal parts of these areas are equal to spherical trapezoids on a globe.

The scales along the meridians and parallels are not equal to the principal scale except on the parallels 40° 44' N. and 40° 44' S., where the scale is correct (Fig. 2).

Aitoff's Equal-Area Projection. (Aitoff, 1800-1864, Russian Don Cossack.) This projection is an ellipse with the major axis twice the minor and is similar to Mollweide's equal-area

⁴ Mercator's projection was designed for nautical charts. The rhumb line is represented as a straight line. To learn the bearing from one point to another, a straight line is drawn between the two positions on the chart. Reading off the angle which this line makes with any meridian and steering the ship on this bearing, the destination is reached.

In the development of air navigation, Mercator's projection is important for long-distance flying with a constant bearing course.

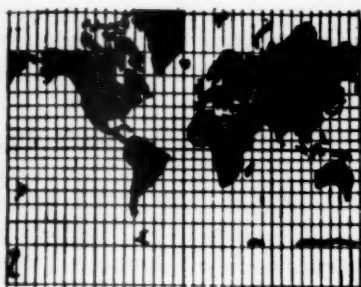


FIG. 1. Mercator's cylindrical conformal projection of the world.



FIG. 2. Mollweide's equal-area projection of the world.



FIG. 3. Aitoff's equal-area projection of the world.



FIG. 4. Lambert's cylindrical equal-area projection of the world.



FIG. 5. Van der Grinten's projection of the world, within one circle.

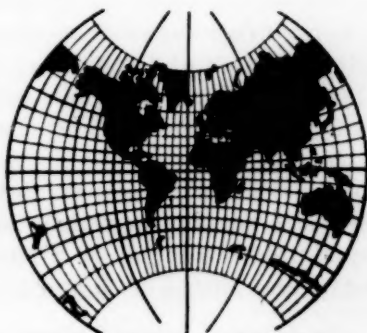


FIG. 6. Lagrange's conformal projection of the world, within one circle.

projection, except that the distortion in the polar regions is less since the parallels are curved lines. Also, there is less distortion in the representation of the countries far east and far west of the central meridian, as the meridians and parallels are not so oblique to one another (Fig. 3).

Lambert's Cylindrical Equal-Area Projection. (Lambert, 1728-1777, German mathematician.) The height of a cylinder tangent to the equator on a globe is equal to its axis. Points equally spaced along the meridians on a globe are projected on the surface of the cylinder by lines parallel to the plane of the equator. The lateral surface of this cylinder, being equal to the surface of a globe, is cut from base to base and rolled out into a plane. The projection is a rectangle, the meridians are equidistant vertical lines, and the parallels are horizontal straight lines spaced closer towards the poles. Areas between two neighboring parallels are equal to the surface of spherical belts and equal parts of these areas are equal to spherical trapezoids on a globe.

The scale is equal to the principal scale only along the equator. As the latitude increases the scales on the parallels become larger, and on the meridians smaller, than the principal scale.

This projection is easy to draw, but it greatly distorts the shape of the continents in high latitudes (Fig. 4).

Van der Grinten's Projection. Van der Grinten, cartographer in Chicago, constructed (1904) his projection for the world within one circle, substituting a globe. This projection is neither conformal nor equal-area and may be classed as intermediate.

The scale is correct only along the equator⁵ (Fig. 5).

Goode's Interrupted Equal-Area Projection. Dr. J. Paul Goode, late Professor of Geography, University of Chicago, devised (1916) the homolographic interrupted projection for continents and ocean units (Figs. 7 and 8).

Johnson's Interrupted Equal-Area Projection. Wm. E. Johnson, cartographic engineer, formerly with the U. S. Coast and Geodetic Survey, arranged the whole world on a sinusoidal equal-area projection in a tripartite map for continents and for ocean units⁶ (Figs. 9 and 10).

⁵ Van der Grinten's projection is somewhat similar to the conformal projection of Lagrange, (1736-1813, French mathematician), as on both, the central meridian and the equator are straight lines and the other meridians and parallels are circular arcs. (Fig. 6).

⁶ Rand McNally & Company, where Mr. Johnson is chief cartographer, have edited eight distribution maps on this projection. They are: Physical Relief, Climatological Regions, Annual Rainfall, Temper-

Boggs' Interrupted Equal-Area Projection. (Dr. S. W. Boggs, Geographer, U. S. State Department.) This eumorphic (good shape of large areas) interrupted equal-area projection is a mathematical mean of the properties between the sinusoidal equal-area projection and the Mollweide homolographic projection from which it is derived (Fig. 12).

Deetz's Interrupted Equal-Area Projection. C. H. Deetz, cartographic engineer, U. S. Coast and Geodetic Survey, arranged a parabolic equal-area interrupted projection of the world, constructed symmetrically in three sections (Fig. 13).

Northern and Southern Hemispheres, are represented on the zenithal (azimuthal) equidistant projection of Postel, on the zenithal (azimuthal) equal-area projection of Lambert, and on the polar stereographic conformal projection.

Postel's Polar Zenithal (Azimuthal) Equidistant Projection. (Postel, 1510-1581, French mathematician.) The tangent plane is at one of the poles. The radii for the parallels are proportional to the lengths of the arcs of the earth's meridians. The meridians are straight lines radiating from the pole. The parallels are concentric circumferences equally spaced on the meridians.

This projection represents the true azimuths and distances from the pole to any points on the hemisphere, and it is neither conformal nor equal-area.

The scale along the meridians is correct. The scales along the parallels are too large, increasing with the distance from the poles. The scale on the equator is one and a half times as large as the principal scale (Fig. 14).

Lambert's Polar Zenithal (Azimuthal) Equal-Area Projection. The tangent plane is at one of the poles. The radii for the parallels are proportional to the chord distances of the parallels from the pole. The meridians are straight lines radiating from the pole, and the parallels are concentric circumferences spaced closer towards the equator. As the area of the circles is equal to the surface of spherical segments on a globe the projection is equal-area.

This projection represents the true azimuths from the pole to any points on the hemisphere.

The scales are not correct along the meridians or parallels.

ature Zones, Distribution of Vegetation, Races of Mankind, Density of Population and Economic Utilization.

Mr. Johnson also devised an uninterrupted modified sinusoidal land surface equal-area projection. (Fig. 11).

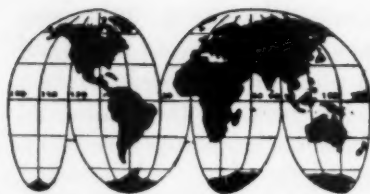


FIG. 7. Goode's interrupted homolographic (equal-area) projection of the world.

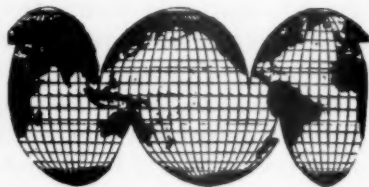


FIG. 8. Goode's interrupted homolographic (equal-area) projection for ocean units.

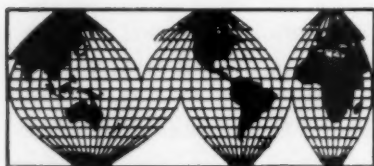


FIG. 9. Johnson's interrupted sinusoidal equal-area projection of the world.

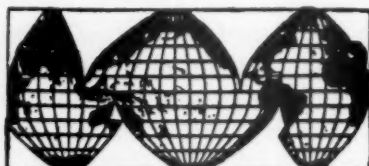


FIG. 10. Johnson's interrupted sinusoidal equal-area projection for ocean units.



FIG. 11. Johnson's uninterrupted modified sinusoidal land surface equal-area projection.

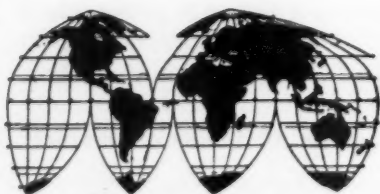


FIG. 12. Boggs' interrupted eumorphic equal-area projection of the world.



FIG. 13. Deetz's interrupted parabolic equal-area projection of the world.

On the meridians the scales are smaller, and on the parallels, larger than the principal scale (Fig. 15).

Polar Stereographic Conformal Projection. Hipparchus (180–125 B.C.) Greek astronomer, invented the stereographic projection. This projection is perspective, with the point of view at one of the poles on a globe and the plane of projection tangent to the opposite pole. The meridians are straight lines intersecting at the chosen pole. The parallels are concentric circumferences with a common center at the pole and the intervals between them increasing towards the equator. As there is no angular distortion the projection is conformal and represents the true azimuths from the pole to any points on the hemisphere.

The stereographic projection is the only one on which all great and small circles on the earth are represented by circles.

The scale is correct in the center of the projection. The scales along the meridians and parallels are larger than the principal scale, and the scale on the equator is twice as large as the principal scale (Fig. 16).

Eastern and Western Hemispheres are represented on the equatorial stereographic conformal projection, on Mollweide's equal-area⁷ projection, and on the neither conformal nor equal-area globular projection.

Equatorial Stereographic Conformal Projection. The point of view is at the equator on a globe, and the plane of projection is tangent to the opposite point on the equator. All meridians and parallels intersect at right angles and are circular arcs with varying radii, except the equator and the central meridian which are straight lines. Both meridians and parallels are spaced closer towards the center. This projection is azimuthal and conformal, and it is the only projection on which all great and small circles on the earth are represented by circles.

The scale is correct in the center but becomes larger than the principal scale on the meridians and parallels approaching the edge of the projection where the scale is twice as large as the principal scale (Fig. 17).

Mollweide's Equal-Area Projection. This projection is a circle with an area equal to the surface of a hemisphere on a given scale. Its properties are the same as those of Mollweide's equal-area projection for the world (Fig. 18).

⁷ For an equal-area representation of the Eastern and Western Hemispheres, Lambert's equatorial zenithal (azimuthal) equal-area projection is also used.

Globular Projection. Nicolosi (1610–1670), Italian Doctor of Theology, constructed his projection as a circle with two diameters at right angles representing the central meridian and the equator which are proportional to the length of the hemisphere's meridian and equator. The circle and both diameters are divided into equal parts and circular arcs are drawn through three given points, namely: the meridians through both poles and one of the points of division on the equator, and the parallels through the points of division on the circle and on the central meridian.

The globular projection is neither conformal nor equal-area.

The scale is correct on the central meridian and on the equator, but on the other meridians and parallels the scales are larger than the principal scale (Fig. 19).

The Continents: Europe, Asia, North America, South America and Australia are represented usually on the equal-area projection of Bonne, and Africa, on the equal-area projection of Sanson.

Bonne's Equal-Area Projection. (Bonne, 1727–1795, French engineer-geographer.) The central meridian is a straight line divided equally, and is proportional to the length of an arc of the earth's meridian. The parallels are concentric circular arcs with the center at the pole. They are divided equally, and are proportional to their true length and at their true distances apart. The meridians are formed by drawing curves through the points of division on each parallel.

This projection is equal-area since all the small elements between any two parallels bounded by two infinitely close meridians are equal to each other and to the same elements on a globe.

The scale is correct along the parallels and the central meridian. The scales along other meridians are too large increasing with the distance from the central meridian (Fig. 20).

*Sanson's Sinusoidal Equal-Area Projection.*⁸ (Sanson, 1600–1667, French geographer.) The central meridian is a straight line divided equally, and is proportional to the length of an arc of the earth's meridian. Though the points of division, straight lines perpendicular to the central meridian represent the parallels. They are divided equally and are proportional to their

⁸ This projection should be credited to Mercator as it was employed in the Mercator-Hondius atlas in 1606 for the map of South America. On this projection the whole world can be represented.

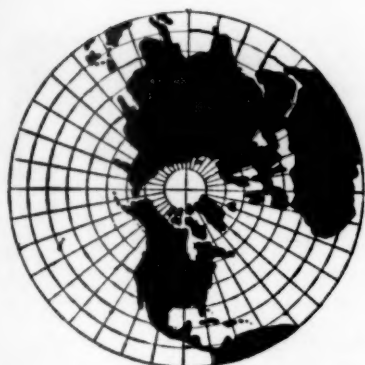


FIG. 14. Postel's polar zenithal (azimuthal) equidistant projection of the northern hemisphere.

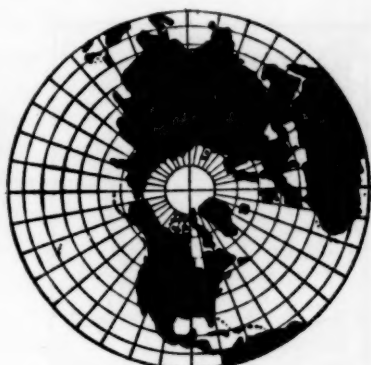


FIG. 15. Lambert's polar zenithal (azimuthal) equal-area projection of the northern hemisphere.

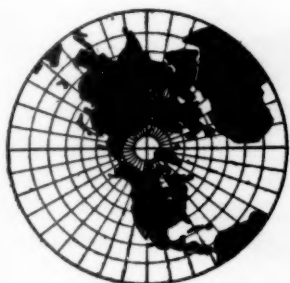


FIG. 16. Polar stereographic conformal projection of the northern hemisphere.



FIG. 17. Equatorial stereographic conformal projection of the eastern hemisphere.



FIG. 18. Mollweide's equal-area projection of the eastern hemisphere.



FIG. 19. Equatorial globular projection of the western hemisphere.

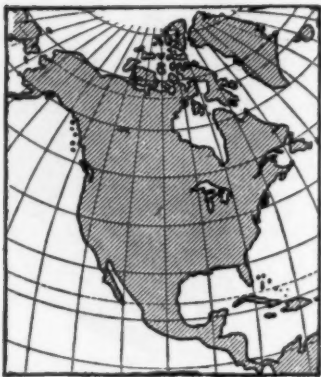


FIG. 20. Bonne's equal-area projection of North America.

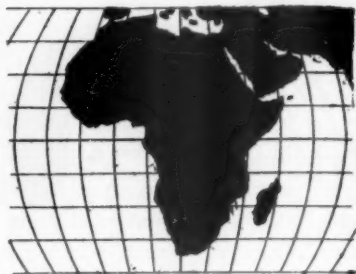


FIG. 21. Sanson's equal-area projection of Africa.

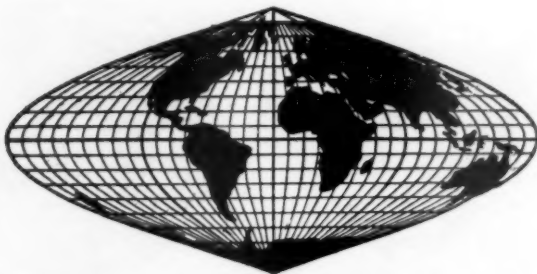


FIG. 22. Sanson's equal-area projection of the world.

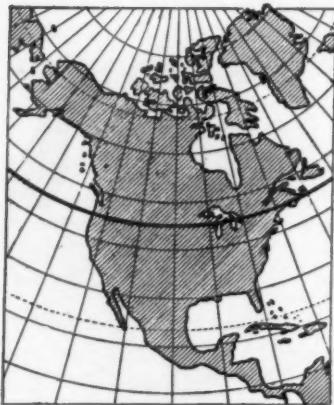


FIG. 23. Simple conical projection of North America with one standard parallel.



FIG. 24. Simple polyconic projection of North America.

true length. Through the points of division on the parallels continuous curves (sinusoids) represent the meridians.

This projection is equal-area since the bases and the heights of all the trapezoids are equal to the arcs of the parallels and meridians and the areas of these trapezoids are equal to the surface of the spherical trapezoids on a globe.

The scale is correct along the parallels and the central meridian. The scales along other meridians are too large, increasing with the distance from the central meridian (Figs. 21 & 22).

Countries and States are represented on conical projections.

Simple Conical Projection. Ptolemy, (87–165 A.D.), Egyptian geographer, invented this projection on which the meridians are straight lines radiating from one of the poles (apex of the tangent cone which if rolled out into a plane would form a sector) and are proportional to the length of arcs of the earth's meridians. The parallels are concentric, equidistant circular arcs, drawn with the center at the pole.

The scale is correct along the meridians and the standard parallel. The scales along the other parallels are larger than the principal scale. Close to the standard parallel the distortion of areas and shapes is small, but with the increase of distance from the standard parallel the distortion becomes considerable⁹ (Fig. 23).

Simple Polyconic Projection. Professor F. R. Hassler (1770–1843), the first Superintendent of the U. S. Coast and Geodetic Survey, devised this type of projection on which the cones are tangent at each parallel making all parallels standard. The central meridian and the equator are straight lines divided equally, and are proportional to their true length. The parallels are non-concentric circular arcs divided equally and are proportional to their true length. The meridians are curved lines equally spaced on the parallels.

The simple polyconic projection is neither conformal nor equal-area.¹⁰

⁹ Modified conical projections provide less distortion of shape and area in regions distant from the standard parallel. If it is desired to make a conical conformal projection or a conical equal-area projection, the distances between the parallels must be modified and the scale along the meridians becomes incorrect in inverse proportion.

Lambert's conical conformal projection with two standard parallels is used by the U. S. Coast and Geodetic Survey for airway maps of the United States.

For an equal-area representation of the United States, Albers' conical equal-area projection with two standard parallels is used.

¹⁰ Modifying the simple polyconic projection it is possible to construct a conformal or an equal-area polyconic projection.

On polyconic projections the whole world can be represented.

The scale is correct along the equator, all parallels and the central meridian. On the other meridians the scales are larger than the principal scale.

The polyconic projections are more suitable for countries of wide latitude and narrow longitude, though they are often used in mapping the United States (Fig. 24.)

REACTION TIME: AN APTITUDE TEST

BY R. B. DELANO

Memorial High School, Boston, Mass.

"What is your reaction time?" is a question often heard in and about the corridors of Memorial High School. The reaction machine is the cause of this accentuated interest.

This machine consists of a cord passing over a pulley which is attached to the ceiling of the classroom. One end of the cord is attached to the shaft of a constant speed motor and the other end is fastened to a small weight or figure. This weight is hidden behind a small screen so that, when in motion, it enters the range of vision rather abruptly. A scale having a limit switch at its upper end is placed near the weight.

A lever (automobile brake pedal) is connected into the motor circuit in such a manner that it will break the circuit when the pedal is depressed. The limit switch and a knife switch are connected in series with the brake pedal switch and electric motor.

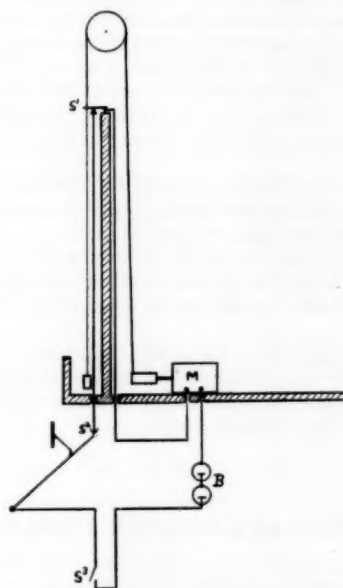
When a student standing behind the person under test closes the knife switch, the weight or figure starts on its upward journey and continues until stopped by depressing the brake pedal. The time required for the person under test to remove his foot from the floor (gas) and place it on the brake pedal can be determined from the scale reading as accurately as 1/200 of a second.

The student assumes that while he is driving 30 miles per hour, a man suddenly steps from the curb 100 feet distant. Can the student stop in time to avoid a serious accident? Breaking distance and reaction time are the factors involved.

Students who usually avoid problem work attack this problem with sedulous interest because it is their problem and its solution is vital to them.

Teachers who wish to interest a student in physics should keep in mind the fact that the goals of the student differ from those of the teacher. It is absurd to think that an objective which motivates a mature mind will always motivate the mind of a child. It is inevitable that the constantly decreasing enrollment in physics, the most fascinating of all high school subjects, will continue until teachers stop teaching the subject as it was taught to them 40 years ago.

It is useless to look to graduate schools or research students for a solution of this problem. They are so absorbed in hair



NOTE: S^2 is a spring contact which does not open until the brake pedal is fully depressed.

splitting correlations, attenuations, and deviations that they have no time to consider it.

Although the reaction time test is a rather crude indication of the motor, mental, and sensory efficiency of a child, it gives some prognosis of his aptitude. If nearly 40,000 people were killed in motor accidents last year, is it not time that those who are to drive automobiles be given some conception of the responsibilities and problems involved? If aptitudes are distributed in accordance with the normal probability curve, ought

we not to protect society from the ravages of those having a reaction time several deviations below the mean?

Since the average student is incapable of applying the general laws of physics to everyday conditions, it is our duty to teach the application as well as the law so that the student may predict the consequences of his action before the consequences overtake him. If this is not true, just why are we teaching physics?

SCIENCE NEWS FROM IOWA

Science for the elementary grades has been designated by the Department of Public Instruction of the State of Iowa under the leadership of Miss Agnes Samuelson as the subject to be given emphasis in the improvement of instruction program for the school year of 1937-1938.

The new course of study bulletin for use in the schools, "A Guide for Teaching Science in Grades One to Eight," was prepared by Lillian Hethershaw of the General Science Department of Drake University, Des Moines, Iowa.

The Bulletin is a State Department of Public Instruction Publication and was presented at the Conference of County Superintendents called by Miss Samuelson, which was held in Des Moines in July 1937.

The bulletin is a suggested course of study in science with units for each of the grades. Book lists for pupils and teachers are given, a list of science magazines, general references, sources of equipment, and visual aids are given.

No topic is more timely, nor none older, than that of Conservation. The theme of Conservation runs through the entire course of study.

The science bulletin may be secured by writing to the State Department of Public Instruction, Des Moines, Iowa.

ELEMENTARY SCIENCE PROGRAM

The Elementary Science Section of the Iowa State Teachers Association held its sixth program at Drake University Nov. 5, 1937.

The following program was presented:

1. The Iowa Science Program. Miss Agnes Samuelson, State Superintendent of Public Instruction, Des Moines, Iowa. Alternate, Miss Lillian Hethershaw, General Science Department, Drake University.

2. "Can Scientific Attitudes and Skills Be Taught in a Class in Elementary Science?" Miss Winifred Gilbert, Iowa State Teachers College, Cedar Falls, Iowa.

3. "Visual Instruction in Elementary Science." H. L. Kooser, in charge of Visual Instruction Service, Iowa State College, Ames, Iowa.

An exhibit of science activities was on display from various School Systems of Iowa in the General Science Rooms at Drake University. The program and the exhibit were very well attended again this year. This is the sixth program and exhibit of this section.

The officers for the year were:

Chairman—Florence Beverley, East Waterloo.

Secretary—Ada Bell, Webster City, Iowa.

WILL SOAPS BECOME OLD-FASHIONED?*

BY V. M. VOTAW

Procter and Gamble, Ivorydale, Ohio

In the discussion of this subject I should first like to trace for you in outline the history of soap making and the development of the modern soap industry. When we then come to the latest developments in detergents, you will be better prepared to judge whether or not these new products are likely to out-mode soaps.

Soaps may or may not become old-fashioned but they are certainly old. As a matter of fact no one knows just how old they are. The name of the man who invented them has never been discovered, which would make it appear that some form of soap-making was handed down from the earliest times. The tendency among historians is to give credit to the Phoenicians as the first people to know soap as a commercial product, but as you know, these people seem to get credit for almost anything of this kind in early history when there is no positive proof for someone else. In any case soap was known and used to some extent by the Gauls as early as 400 B.C. and it may have been introduced there by the Phoenicians.

The Romans, always quick to acquire and adapt to their own uses anything which enhanced their personal comfort and appearance, took up the art. In the ruins of Pompeii, the Roman city which was covered by an eruption of Vesuvius, has been found the remains of an establishment for making soap. Soaps were widely used among the cultured classes for washing themselves and their clothing and were a part of the luxury and civilization of Rome.

When the barbarians came, all this was changed and the use of soap and knowledge of soap making practically disappeared. The barbarians were unused to creature comforts, had no knowledge of them, and were not likely to have any use for soap. For five hundred years or so no mention of it is made anywhere. During the Crusades the people of Western Europe learned about the use of perfume. There arose a decided tendency among those who could afford it to use perfume to cover up "unwashed" odors rather than to remove them by washing. All this sounds rather primitive but I believe I can show you

* Read before the Chemistry Section of the Central Association of Science and Mathematics Teachers, Cincinnati, November 26, 1937.

a little later that the situation was almost as bad up to the time of our grandfathers. Finally during the Renaissance the making of soap was revived in a small way at Savona in Italy. It is from this town that soap acquired its name; in French *savon*, Spanish *jabon*; German *seife*; and in English *soap*.

At the time Columbus discovered America, Marseilles in France had become the soap center of the world and put soap on its first real commercial footing. Perhaps here we should say something about the earliest soap making methods since this development at Marseilles marked the highest development of the old methods. The big difficulty in making soap in ancient and medieval times was the procuring of the necessary alkali. At first soaps were made by simply cooking together fats and wood ashes which made a very crude soap indeed. Later the Romans may have obtained sodium carbonate from deposits in Asia Minor and Africa although this is not certain. It is certain that they made an alkali, principally Na_2CO_3 , by burning seashore and sea plants. This alkali was called *barilla*. It was used either directly or later was treated with lime to give a more useful product for soap making. As you know, Na_2CO_3 and K_2CO_3 will saponify fatty acids but will not saponify neutral fats in the ordinary methods of soap making. Caustic soda and potash are necessary for this more difficult saponification. When these people used the carbonates directly, they undoubtedly often had a large excess of neutral fat in their final product. Nobody knows the name of the man who found that it was advantageous to treat the leachings of the ashes with lime before boiling them with the fat.

The soap making in Marseilles was carried on in the way just described. They used leachings of the ashes of sea plants for hard soaps and those of land plants for soft soaps. These leachings were usually treated with lime before being used in saponification. No liquors were saved since these people knew nothing of the existence of glycerin.

The industry made little progress in a technical way for another three hundred years. The next place in its development began when the French Academy of Science in 1775 offered a prize amounting to 100,000 francs, about \$12,000, to anyone discovering a practical method of making soda from common salt. In 1794 Nicolas LeBlanc, a physician to the Duke of Orleans won the prize with a process which was able to hold its own for a hundred years. You remember how it went. Salt was

heated with H_2SO_4 to give Na_2SO_4 or the "salt cake." Na_2CO_3 was formed by heating the salt cake to a high temperature with limestone and coke. The third step was leaching the "black ash" thus formed to separate Na_2CO_3 from CaS . Later the sulfur was also recovered and this by-product was one of the reasons this method of producing soda ash was able to survive as long as it did.

Unfortunately LeBlanc was on the wrong side politically in the French Revolution. The Duke of Orleans' head was cut off, and the factory which he had built for LeBlanc was confiscated. In addition, LeBlanc could never collect the prize money. In 1800 his factory was given back to him but he was too poor to start operations and finally was brought to such straits that he killed himself six years later. His invention was taken up in England, France and the United States, however, and has been a very important one both to chemical industry and civilization. Neither the soap industry nor the making of glass could have entered upon their modern developments without it. In addition, since it required huge quantities of H_2SO_4 , the modern methods of producing this substance were perfected which in turn brought about the cheapening of many chemical processes. The amount of sulfuric acid used in a country has been used as an index to the state of civilization in that place. Another turn taken by the LeBlanc discovery with its very great effect on the soap industry was to concentrate attention on the nature of fats and the waste liquors from soap making. Chevreul and Scheele identified and separated glycerin, Nobel finally made an explosive from it and made possible modern methods of warfare. The LeBlanc process was finally displaced completely by the modern Solvay process between 1890 and 1900.

Although the soap industry in the United States kept pace fairly well even in the early 1800's, there was an enormous amount of home making of soap in the early days. This home industry was fostered by the independent spirit of the pioneers, the great distances from markets, and the poor methods of transportation. Home making of soap has now died out almost completely but even as late as when I was a boy, we made all our laundry soap at home. This included rendering the fats, making the alkali by leaching wood ashes which were saved and stored in barrels, and boiling them together to make a soft soap. I can't help but feel that it must have been a poor product.

Lack of adequate supplies of fat was very definitely a factor

preventing mass production of soaps in the first half of the nineteenth century in this country. When the original partners of The Procter & Gamble Company began their business together in 1837, it was their practice to gather up fats from door to door in a wagon. After the Civil War, large meat packing plants were started and these plants became depots for the accumulation and storage of large quantities of fats.

Partly because the packing industry in this country is so large and is the source of supply of soap fats, and partly because it makes such good soap, tallow has become the basic soap-making fat. With tallow in practically all soaps at present, there is used a smaller amount of cocoanut oil to give quicker sudsing, better performance in cold and hard water, and the proper firmness in bar soaps. Cocoanut oil is usually imported in the form of copra which is the dried meat of the cocoanut. The cocoanut palm is widely distributed in the tropics but the copra of commerce comes principally from the Philippines and Ceylon. The tree produces about two hundred nuts each year. All the nuts do not ripen at once so it is necessary to harvest the crop about every forty-five days the year round. After they are husked, they are split open, the milk is usually wasted, and are then dried until the meat peels from the shell. This drying was formerly done in the sun but dryers which produce copra of better quality are coming more and more into common use.

For other countries whose supply of tallow is considerably less than ours, palm oil is the basic soap-making fat. Palm oil is obtained from a different type of palm entirely which grows along the west coast of Africa near the Equator. Recently plantings have been made by the Dutch in Sumatra which promises to become a serious competitor of the African west coast in palm oil production. The oil is obtained from a cluster of rather fleshy fruits which grow at the very top of the palm. Each of these fruits contain very hard seeds called palm kernels which are about the size of a hazel nut. Palm oil is obtained from the fruit, while the seeds yield palm kernel oil which is entirely different from palm oil and which resembles cocoanut oil rather closely. The primitive method of obtaining palm oil was to pile the fruits in a pit in the ground and allow them to remain for two or three weeks until they had fermented. The natives then began treading in the pit until the fruit was broken up so the oil could be squeezed out. This process gave a poor and usually rancid grade of oil. The more modern method is to boil the

fruits until the oil separates to the surface. This clear oil is skimmed off and settled to separate water. In this way a clear yellow oil of a buttery consistency with a pleasant violet odor is obtained.

The use of soap products as far as personal cleanliness is concerned, at least, lagged behind the technical improvements in production. Some of you, I feel sure, will be surprised at the date of the installation of the first bathtub having running water. In that connection you are in an historic place. The first such bathtub in the country was installed in Cincinnati in the home of Adam Thompson on December 20, 1842. The contraption was built of mahogany and lined with lead and as you may suppose created quite a stir. Many people seemed to think there was something sinful about such a method of taking a bath and it was not until President Millard Fillmore, when on a stumping speech in 1850 visited the Thompson home in Cincinnati, saw and used the bathtub, and was so taken with it that he had one installed in the White House that the prejudice began to die out.

At the present time there is about 30 pounds of soap produced each year for every man, woman and child in the United States. About two-thirds of this amount is used in the home and one-third in industry. No other country approaches the United States in its per capita soap production. Soap usage is often taken as an index of the standard of living. All this may make us feel very good but we still have a long way to go in this direction. A recent survey has shown that the average frequency of bathing among all classes of people in this country is once every three weeks in summer. One can only guess what it is in winter. There are apparently still many people who are sewn into their underwear from November until April.

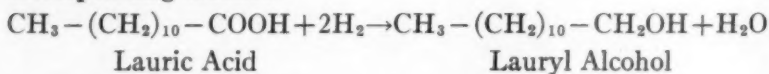
From the very first and on down through the ages until the present time, soap has had one outstanding disability. The sodium and potassium salts of fatty acids, which are our present soaps, are soluble in water but the corresponding calcium, magnesium and other metallic salts are not. When soaps are dissolved in water containing calcium and magnesium, these metals combine with the fatty acid in the soap to form insoluble soaps. Since most natural waters are hard to some degree through the presence of calcium or magnesium, lime soap formation occurs almost every time a soap is used. All of the hardness must be precipitated by the soap before any sudsing or

washing can take place. This reaction not only uses up large quantities of soap but the lime soap precipitate formed is deposited on everything it touches. The present day developments in detergents aims at overcoming this disability of soap.

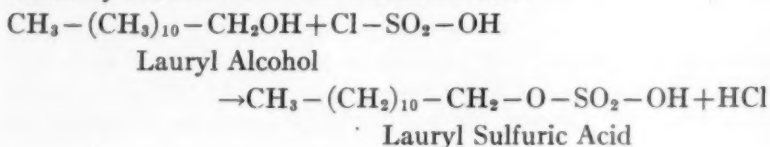
During the war when Germany was cut off from the outside world, fats became so scarce that they could hardly be spared for soap making. This shortage stimulated the search for other types of detergents, and although this work did not solve the immediate problem, it led to the discovery a few years later of a new type of compounds valuable as washing agents. These compounds are the salts of sulfated high molecular weight alcohols and as a class are called by a coined name "hymolal salts." No one individual or group has been alone responsible for the discovery and practical application of this class of compounds, but two names are outstanding in their development. N. Bertsch of H. T. Böhme, A.-G., was the first to show that the carboxyl group of the fatty acids must be blocked or eliminated in some way if lime soap formation is to be prevented. Schrauth of Deutsche Hydrierwerke A.-G. solved some of the major practical problems involved in manufacturing the compounds.

High molecular weight alcohols occur widely distributed in nature but in such low concentrations that recovery on a practical scale is impossible. The best known of these natural occurring heavy alcohols are cholesterol and phytosterol found as a part of the unsaponifiable matter in animal and vegetable fats. The amounts of these materials vary with the source of fat but seldom make up more than 0.1% of the weight of the fats.

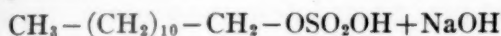
The first step in producing hymolal salts in practical quantities was, then, the discovery of a source of the high molecular weight alcohols. This problem was solved by a special catalytic hydrogenation process whereby fatty acids are reduced to the corresponding alcohol.



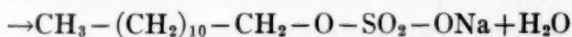
In making the detergents, the next step is sulfation brought about by reaction with chlor-sulfonic acid.



The alkyl sulfuric acid is neutralized with a suitable base. This base may be caustic soda or potash, ammonia, magnesium hydroxide or other alkaline materials depending on the type of product desired.



Lauryl Sulfuric Acid



Sodium Lauryl Sulfate

These salts possess unusual properties which give them advantages over soaps. Some of these are listed below.

1. They are more powerful sudsing agents than soap.
2. They are not affected by hardness of water since both the magnesium and calcium salts are soluble in warm water.
3. They are good sudsing agents in acid solutions. Acid decomposes them only very slowly. They are also stable in alkaline solutions.
4. The salts are neutral both in the solid form and in solution.

We believe we can demonstrate each one of these advantages over soaps with the solutions we have in these cylinders.

Very much less of the hymolal detergents than of soap are necessary to produce suds and wash in hard water. Even in water of 10 grains hardness, which is very little above the average for the United States, from one-third to one-half of the soap used in washing goes for softening the water.

This great quantity of soap used up by hard water is, of course, turned into calcium and magnesium soaps. These compounds are sticky and heavy. They settle on clothes, face, hands, hair, the bowl or tub used for washing and cling stubbornly to everything they touch. They cannot be removed by rinsing. As a result, cloth tends to become stiff and yellow if it is white, or if it is printed or colored, to become faded and dim, and, in addition, lime soaps probably have a deleterious action on the cloth. These deposits make bathrooms, wash tubs and dishpans hard to keep clean. Hair shampooed with soap under hard water conditions loses its natural sheen because of the film of lime soaps which encases each hair and tends to make the hair stiff and brittle.

Hymolal detergents solve this hard water problem in a most effective way. Hair, for example, when freed from lime soap deposits by a shampoo with these new washing agents, takes on its natural sheen and luster and appears and feels soft. There

is no ring around the washbowl, and colors of printed fabrics remain clear and bright. Even in sea water these materials make an abundant suds.

The preservation of colors brings us to another important practical advantage of hymolal salts as washing agents. These salts and their solutions are neutral, having a pH of about 7. Soap solutions, on account of hydrolysis of the soap, are always alkaline with a pH of 10 to 11. The neutrality of the hymolal detergents gives them a considerable advantage over soaps in preserving the colors of fabrics. Many dyes exhibit entirely different colors in acid and alkaline solutions and a change in shade on going from an acid to an alkaline solution is the rule rather than the exception. It happens that several large classes of dyestuffs exhibit the desirable shades in acid solutions and are, therefore, put on the cloth in solutions of this type. For example, direct dyes, a very important group, are put on cotton, rayon and silk fabrics in a dye bath having a pH of 6.5 to 8.0. Chrome dyes, mordant dyes, and acid dyes are put on woollens in a bath having a pH of 2.0 to 4.0. These colors all remain nearest their true shade when washed in solutions having a pH near that of the dye bath in which they were put on the cloth. Washing in alkaline solutions often causes "off" shades of the color to result. Even more serious is the tendency of the dyed cloth to lose color in alkaline solutions. If there is any tendency to fade, the fading will be greater the higher the pH of the washing solution. By permitting the washing of fabrics at very near the pH at which they were originally dyed, hymolal salt detergents minimize loss or change of color.

Loss of color may also occur if washing is carried out at too high a temperature. Because these new cleansing agents are readily soluble even in cold water, there is no temptation to start washing in water too hot for colors as there is if soap flakes are used.

These new materials have advantages in washing dishes, glassware, and windows. Since no lime soaps are formed on rinsing, the tendency to streak is eliminated. Dishes and glassware will dry with a polish.

The cleaning of chemical glassware has also been suggested by several enthusiastic users. Grease is removed better than with the regular cleaning solutions, and with much less inconvenience and danger.

Finally, what is the future of the alkyl sulfate detergents and

other soapless detergents which are being developed? You have seen that they have very definite advantages over soaps which everything else being equal, should make soaps obsolete very shortly. Everything else is not equal, however, for the soapless detergents are much more costly to produce. For this reason the use of these detergents is limited at present to situations where their special applications are most apparent. Our product, Dreft, for example, is offered principally in hard water areas and for washing fine fabrics and dishes.

In addition, it does not appear that the price per pound would ever be as low as for soaps. One or two extra processing steps over those necessary for soap making will always be necessary.

To adopt the attitude that these disadvantages will never be overcome, however, would be very foolish in the face of the technical improvements and discoveries constantly going on. It is very possible that new compounds or improvements in the ones we have discussed may be made which will overcome the disadvantage in price. If this occurs, soaps will be very likely to diminish in importance. Under present conditions, however, soaps are in little danger of being replaced.

JUNIOR AUDUBON CLUBS

Do you know that the National Association of Audubon Societies, 1775 Broadway, New York City, is able, because of its endowment, to supply certain educational materials to teachers and children at approximately half actual cost?

Do you know about the Junior Audubon Clubs? During the school year 1936-37, 6201 such Clubs were formed and 170,210 children enrolled as members. Since the inception of this Club plan, over 5,500,000 children have enrolled.

The object of the Audubon Association in stimulating the formation of such Clubs is to further appreciation and protection of birds. The future of American wild life lies in the hands of our children.

Ten or more children may form a Junior Audubon Club, each bringing to the teacher or leader a fee of 10¢. Each child will receive six beautiful bird pictures, with six outline drawings which may be colored; with these, six four-page leaflets written by well-known authorities on bird life. Each Club member also receives an attractive Audubon button, which serves as a badge of membership in the Club; this year's button displays the Yellow-throat.

If twenty-five or more children form a Club, the teacher, leader, or Club itself receives free a year's subscription to *Bird-Lore*, which is the illustrated magazine of the Audubon Association. This contains much material helpful to the teacher and interesting to both child and teacher.

Forming a Junior Audubon Club is a splendid way to vitalize natural science work, as well as awaken in the boys and girls appreciation of the beauty and economic value of our native birds.

MATHEMATICS—TO REASON NOT JUST TO DO

BY JOSEPH SPEAR

Northeastern University, Boston, Mass.

Some time ago at a meeting of mathematics teachers, the author suggested the use of reasoning methods rather than rules and short cuts in the teaching of fractions in both arithmetic and algebra. The purpose was to try to eliminate mistakes due to faulty memory in trying to remember short cuts and rules which had no meaning. Work with equations was also discussed from a similar point of view. There seemed, then, to be some agreement that the methods suggested might be of value.

Recently at another meeting of the association, during the consideration of problems presented to the high school algebra teacher arising from the different degrees of preparation among the students, the same topic of difficulty in fractions was again discussed and to many present the methods suggested earlier appeared as brand new ideas.

The author is therefore moved to put his recommendations in writing, not in the belief that there is anything new in them, but with the hope that teachers will at least give some of the suggestions a trial. Much progress has been made in the last two or three decades in methods of teaching history, geography, and reading. In arithmetic, however, many of the same old tricks resorted to years ago are still being used, and the same complaint is continually heard that the students can't even add fractions.

Even though the method outlined here may not cure all evils, it surely cannot turn out worse results than we see at present, and it may by chance make improvements in the student's learning and his retention of learning. The method has been tried for eighteen years with college freshmen and has been particularly beneficial to those students who claim they have always found mathematics hard to understand.

In order not to be too lengthy, the methods will merely be outlined. The teacher can readily fill in between the lines where necessary.

First of all, in dealing with fractions, the only operation permitted, in order not to change the value of a fraction, is to multiply it by unity or to divide it by unity. The unity may be disguised in various forms in order to accomplish the desired end, but multiplication or division by the factor of unity is the only privilege permitted.

The UNITY METHOD illustrated:

$$\begin{aligned}\text{Ex: } \frac{3}{4} + \frac{5}{9} &= \left(\frac{3}{4}\right)\left(\frac{9}{9}\right) + \left(\frac{5}{9}\right)\left(\frac{4}{4}\right) = \frac{27}{36} + \frac{20}{36} \\ &= \frac{27+20}{36} = \frac{47}{36}.\end{aligned}$$

Here each fraction is multiplied by a unity, the proper unity being chosen in order that the resulting fractions should each have the same common denominator. The so-called method of cross-products, of multiplying the numerator 3 by the denominator 9, and multiplying the numerator 5 by the denominator 4, should be entirely discarded. It may be a short cut in some cases, but leads to wrong thinking and no reasoning.

$$\begin{aligned}\text{Ex: } \frac{5}{6} - \frac{4}{15} &= \left(\frac{5}{6}\right)\left(\frac{5}{5}\right) - \left(\frac{4}{15}\right)\left(\frac{2}{2}\right) = \frac{25}{30} - \frac{8}{30} \\ &= \frac{25-8}{30} = \frac{17}{30}\end{aligned}$$

$$\begin{aligned}\text{Ex: } \frac{2}{9} + \frac{1}{4} - \frac{7}{30} &= \left(\frac{2}{9}\right)\left(\frac{20}{20}\right) + \left(\frac{1}{4}\right)\left(\frac{45}{45}\right) - \left(\frac{7}{30}\right)\left(\frac{6}{6}\right) \\ &= \frac{40}{180} + \frac{45}{180} - \frac{42}{180} = \frac{40+45-42}{180} = \frac{43}{180}.\end{aligned}$$

The advantage of requiring that each unity be put in where it is to be used as a multiplier is obvious. Indeed, for some students, where the instruction need be more forceful, it may be desirable to have each unity written in with colored pencil. The student here is using correct reasoning, and must realize that he is not changing the values. No trick is resorted to. Each fraction multiplied by unity does not change in value, although it does change in appearance. The method of finding the proper unity to use in each case as a multiplier for each fraction does not present any difficult problem.

Here is a similar example in algebra:

$$\begin{aligned}\frac{3x-2}{a^2-b^2} + \frac{7}{3(b-a)} - \frac{5}{4(a+b)} &= \frac{3x-2}{(a-b)(a+b)} \left(\frac{4}{4}\right) \left(\frac{3}{3}\right) \\ &+ \frac{7}{3(b-a)} \left(\frac{-1}{-1}\right) \left(\frac{4}{4}\right) \left(\frac{a+b}{a+b}\right) - \frac{5}{4(a+b)} \left(\frac{3}{3}\right) \left(\frac{a-b}{a-b}\right)\end{aligned}$$

$$= \frac{(3x-2)(4)(3)+7(-1)(4)(a+b)-5(3)(a-b)}{(a-b)(a+b)(4)(3)} \text{ etc.}$$

In the reduction of fractions, similar steps should be required. The reduction of a fraction to lowest terms by cancellation leads to vicious habits. In fact, it is suggested that the word cancellation be used only in cases where a term subtracted from itself gives zero. The word cancellation is now being used to cover a multitude of abuses. If reduction of fractions is handled only by the unity method, the reasons involved in the work can be seen and more easily remembered:

$$\text{Ex:} \quad \frac{4}{18} = \frac{2}{9} \left(\frac{2}{2} \right) = \frac{2}{9} (1) = \frac{2}{9}$$

$$\begin{aligned} \text{Ex:} \quad \frac{x^2-2x-3}{x^2-4x-5} &= \frac{(x-3)(x+1)}{(x+1)(x-5)} = \frac{(x-3)}{(x-5)} \frac{(x+1)}{(x+1)} \\ &= \frac{(x-3)}{(x-5)} (1) = \frac{x-3}{x-5} \end{aligned}$$

This treatment of fractions by the unity method should begin as soon as fractions are started in arithmetic, whether it be in the 5th, 6th, or 7th grades. Perhaps it would be wise to postpone the start of fractions until the upper grades, in order that the student may learn more easily and effectively than at present through the reasoning processes involved in applying the unity method. The method too often taught, and presented in many grade school books, of multiplying the 3 by the 5, and

$$\text{the 2 by the 4 in } \frac{3}{4} + \frac{2}{5} = \frac{3 \times 5 + 2 \times 4}{4 \times 5} \text{ does not teach the}$$

student to reason, and in most cases becomes merely a matter of rote memory. The result of teaching such short-cut methods is that the learning is not retained. Furthermore, the student frequently invents new short cuts and tricks, dubious systems of arithmetic with which every teacher is only too familiar.

It is worth mentioning here that besides adding fractions along a horizontal line they should also be done in a vertical column. Very often arithmetic books teach the addition of fractions entirely in vertical columns, and then when the change comes in algebra to adding fractions in a horizontal line the student thinks something new is happening.

$$\begin{aligned}
 \text{Ex: } +\frac{3}{14} &= +\frac{3}{14}\left(\frac{5}{5}\right) = +\frac{15}{70} \\
 +\frac{4}{5} &= +\frac{4}{5}\left(\frac{14}{14}\right) = +\frac{56}{70} \\
 -\frac{3}{10} &= -\frac{3}{10}\left(\frac{7}{7}\right) = -\frac{21}{70} \\
 \hline
 \frac{15+56-21}{70} &= \frac{50}{70} = \frac{5}{7}\left(\frac{10}{10}\right) = \frac{5}{7}(1) = \frac{5}{7}
 \end{aligned}$$

In complex fractions and in fractions with negative exponents this unity method not only tends to foster better habits, but also results in quicker solutions than can be obtained by most

other methods. In the example $x + \frac{1}{y}$ the cross product and

short cut methods often lead to the following incorrect results:

either $\frac{xy+1}{2}$, or $\frac{x+1}{2y}$, or $\frac{2xy+2}{y}$. By the unity method the

operation permitted is to multiply our fraction by one. Here

the unity takes on the appearance of $\frac{y}{y}$:

$$\text{Ex: } \frac{x + \frac{1}{y}}{2} = \frac{x + \frac{1}{y}}{2} \left(\frac{y}{y}\right) = \frac{xy+1}{2y}$$

In fractions of the type $\frac{\frac{a}{b} + \frac{c}{d}}{\frac{m}{b} + \frac{n}{d}}$ too often the student is

taught to reduce the numerator to a single fraction, to reduce the denominator to a single fraction, to tumble the denominator fraction up-side-down, and then multiply. This is neither good mathematics nor good reasoning. Again it too often results in new inventions, as soon as the problem is changed into a little

different form. The short cut of multiplying a by d and b by c , and m by d and n by b , in this particular problem may lead to

the correct answer. But in the example $\frac{\frac{a}{b} + \frac{c}{d}}{\frac{m}{p} + \frac{n}{q}}$ the cross product

method too often leads to the incorrect result $\frac{ad+bc}{mq+np}$, the

student discarding the denominators without realizing it. The steps here in the unity method are:

$$\text{Ex: } \frac{\frac{a}{b} + \frac{c}{d}}{\frac{m}{b} + \frac{n}{d}} \left(\frac{bd}{bd} \right) = \frac{\frac{a}{b} (bd) + \frac{c}{d} (bd)}{\frac{m}{b} (bd) + \frac{n}{d} (bd)} = \frac{ad+bc}{md+nb}$$

$$\text{Ex: } \frac{\frac{a}{b} + \frac{c}{d}}{\frac{m}{p} + \frac{n}{q}} \left(\frac{bdpq}{bdpq} \right) = \frac{adpq+bc pq}{bdmq+bdn p}$$

Reasons for introducing the following additional examples are obvious:

$$\text{Ex: } \frac{3 + \frac{1}{2}\sqrt{a-x}}{4} = \frac{3 + \frac{1}{2}\sqrt{a-x}}{4} \left(\frac{2}{2} \right) = \frac{6 + \sqrt{a-x}}{8}$$

$$\text{Ex: } \frac{x+5+\frac{6}{x}}{1-\frac{6}{x}+\frac{8}{x^2}} = \frac{x+5+\frac{6}{x}}{1-\frac{6}{x}+\frac{8}{x^2}} \left(\frac{x^2}{x^2} \right) = \frac{x^3+5x^2+6x}{x^2-6x+8}$$

$$\begin{aligned} \text{Ex: } \frac{x+5+6x^{-1}}{1+6x^{-1}+8x^{-2}} &= \left(\frac{x+5+6x^{-1}}{1+6x^{-1}+8x^{-2}} \right) \left(\frac{x^2}{x^2} \right) = \frac{x^3+5x^2+6x}{x^2+6x+8} \\ &= \frac{x(x+3)}{(x+4)} \left(\frac{x+2}{x+2} \right) = \frac{x(x+3)}{x+4} (1) = \frac{x(x+3)}{x+4} \end{aligned}$$

$$\text{Ex: } \frac{xy^{-2}+x^{-1}y}{x^{-2}+x^{-1}y^{-3}+x^2} = \frac{xy^{-2}+x^{-1}y}{x^{-2}+x^{-1}y^{-3}+x^2} \left(\frac{x^2y^3}{x^2y^3} \right) = \frac{x^3y+xy^4}{y^3+x+x^4y^3}$$

$$\begin{aligned} \text{Ex: } \frac{\frac{ab^{-1}}{c} + \frac{1}{2}b^3x + c^{-2}}{ax^{-2} + ab + c^{-3}} &= \frac{\frac{ab^{-1}}{c} + \frac{1}{2}b^3x + c^{-2}}{ax^{-2} + ab + c^{-3}} \left(\frac{2bc^3x^2}{2bc^3x^2} \right) \\ &= \frac{2ac^2x^2 + b^4c^3x^3 + 2bcx^2}{2abc^3 + 2ab^2c^3x^2 + 2bx^2} \end{aligned}$$

$$\begin{aligned} \text{Ex: } \frac{x(1-x)^{-1} + x^{-1}(1-x)}{x(1-x)^{-1} - x^{-1}(1-x)^{-1}} &= \frac{x(1-x)^{-1} + x^{-1}(1-x)}{x(1-x)^{-1} - x^{-1}(1-x)^{-1}} \left[\frac{(1-x)x}{(1-x)x} \right] = \frac{x^2 + (1-x)^2}{x^2 - 1} \end{aligned}$$

It is believed that the use of the unity method right from the start will tend to eliminate many mistakes which persistently crop up in the work of altogether too large a number of the students in high school algebra and arithmetic classes, and which cause the classroom work to slow down so much that not sufficient ground can be covered by those desiring to go ahead further in the study, or what is even worse, cause teachers to pass students into higher grades without proper preparation. If the student is never taught that the reduction of $\frac{4}{6}$ is obtained by crossing out or cancelling a 2 from the numerator and denominator, if the student is never taught that the reduction

of $\frac{xy}{ay}$ is obtained by crossing out or cancelling the y 's from the

numerator and denominator, then perhaps the student will

stop crossing out the 3's in the fraction $\frac{x+3}{y+3}$. If the student is

never taught to take things from the numerator to the denominator, etc., perhaps he will not take the 2 down from the numer-

ator of $x + \frac{y}{2}$ into the denominator and call it erroneously $\frac{x+y}{2a}$.

A common mistake in the reduction of $\frac{\sqrt{4-x^2} - x(4-x^2)^{-1/2}(-x)}{4-x^2}$

is to write it as $\frac{\sqrt{4-x^2}-x(-x)}{(4-x^2)(4-x^2)^{1/2}}$. The use of unity method has cured this evil in many, many cases.

$$\text{Ex: } \frac{\sqrt{4-x^2}-x(4-x^2)^{-1/2}(-x)}{4-x^2} \left[\frac{(4-x^2)^{1/2}}{(4-x^2)^{1/2}} \right] = \frac{4-x^2+x^2}{(4-x^2)^{3/2}}.$$

In the rationalizing of fractions the unity method frequently helps. Too often, since $\frac{1}{\sqrt{2}} = \frac{\sqrt{2}}{2}$, students also take a short cut and write that $\frac{1}{\sqrt[3]{2}}$ gives $\frac{\sqrt[3]{2}}{2}$. By use of the unity method the danger of falling into this mistake is lessened.

$$\text{Ex: } \frac{1}{\sqrt{2}} = \frac{1}{2^{1/2}} \left[\frac{2^{1/2}}{2^{1/2}} \right] = \frac{2^{1/2}}{2^1} = \frac{\sqrt{2}}{2}$$

$$\text{Ex: } \frac{1}{\sqrt[3]{2}} = \frac{1}{2^{1/3}} \left[\frac{2^{2/3}}{2^{2/3}} \right] = \frac{2^{2/3}}{2^{3/3}} = \frac{\sqrt[3]{2^2}}{2}.$$

Even if the best unity is not chosen, the chances of getting a wrong result are lessened.

$$\text{Ex: } \frac{1}{\sqrt[3]{2}} = \frac{1}{2^{1/3}} \left[\frac{2^{1/3}}{2^{1/3}} \right] = \frac{2^{1/3}}{2^{2/3}} \left[\frac{2^{1/3}}{2^{1/3}} \right] = \frac{2^{2/3}}{2}.$$

One word of caution should be given here. The student must be taught to be honest in his multiplication. That is, having chosen a given unity, the multiplication must be honest, come what may. In trying to change students over from the old short-cut methods to this unity method, the author has often found that at first, although the student chooses the correct unity, he then ignores it and writes the answer as he thinks it ought to be judging from his old learning, without actually doing the multiplication. This is one of the difficulties that always arises when relearning is attempted. Probably if the unity method were taught from the start, this tendency would never appear.

When students become proficient in finding how to set up the necessary unity, it is possible to learn quickly how, in one step, to reduce into best form a fraction which is complex, containing negative exponents, having common factors in numer-

ator and denominator, and requiring rationalization. However, as has been shown above, even though the most advantageous unity is not chosen, the work will not be wrong, but may require an additional application of another unity. In the long run, the unity method is really a good short method, and what really counts is that it is good common sense reasoning.

One more suggestion is in order concerning equations. Just as in fractions, the general use of the word cancellation should be eliminated. Things are cancelled only when subtraction gives zero. In an equation, the requirement should always be to multiply both sides by the same thing, or to add the same thing to both sides. Transposing from one side to the other leads to errors due to poor memory as to what it is that can be transposed. The use of cross multiplication to clear of fractions is another vicious process which should never be taught. Given

the equation $\frac{x}{2} = \frac{a}{3}$, by multiplying both sides by 6, we get

$$(6) \frac{x}{2} = (6) \frac{a}{3} \text{ or } 3x = 2a.$$

The 3 in the left member of the last equation is not the 3 from the right hand denominator of the first equation. It is the result

of multiplying $\frac{x}{2}$ by 6. In the solution of $5x = 7$, to take the 5

from the left member and place it under the right member is not good thinking. Both sides should be divided by 5, or multiplied by $\frac{1}{5}$ if one prefers.

Examples need not be given of the ridiculous mistakes made when the student thinks he is using the cross-product method, particularly when more than two terms appear in the equation. Nor need examples be given of the errors caused when students think they are transposing, when they are really taking pieces of terms and factors and putting them upstairs, downstairs, and all over the place. To insist that both sides of the equation must be multiplied by the same thing, helps the student to keep continuously in mind the fact that he is dealing with a balanced scale. When one member of the equation happens to be zero, this method will also incidentally finally teach that multiplication by zero gives zero.

In a recent experiment, a large group of students were asked

to solve the equation $\frac{2}{x} = 5$. The papers were immediately

collected. The same students were then asked to solve $\frac{3}{x} = 7$,

but this time they had to indicate exactly what they did to both sides of the equation. The results in the second problem were almost entirely correct, while there were altogether too many errors in the first set. What is still more interesting is that a number of students who had the second problem correct were surprised when they were shown that they had made an error in the first problem.

If in an equation there appear fractions with negative exponents, or fractions that are complex, these fractions should first be reduced by the application of the proper unity multiplier. Then the solution of the equation should be undertaken by treating both sides alike, and if necessary the steps in the treatment should be indicated, just as the unity multiplier is indicated in the treatment of fractions. Note that the two processes are entirely distinct. The unity method is not used for equations. The unity method is used in changing the appearance of a fraction while its value is not altered. In an equation, as long as it is kept balanced, the original value of a member on any one side of the equation need not be retained. Here, therefore, we can multiply both sides by the same thing or add the same thing to both sides.

In all that has been said here, the fundamental idea is to lead the student to understand the reasons for doing things. In fractions, the restriction of being permitted to multiply only by unity will help eliminate the ruination of many fractions. In dealing with equations, if the student learns to treat both sides like the two sides of a balanced scale, he will save many an equation from taking on meanings never intended for it.

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CONSERVATION OF OUR BIOTIC RESOURCES

BY JOHN P. WESSEL

Wright City Junior College, Chicago, Ill.

FOREWORD

The major portion of the contents of this paper has been gathered chiefly from two sources, Parkins, A. E. and Whitaker, J. R., *Our National Resources and Their Conservation*, and Shelford, V. E., *Naturalists Guide to the Americas*. The remaining portion represents a few of the observations made by the author while traveling through the western states during the summer of 1937.

The literature on conservation is so scattered and frequently so voluminous that it is not easily accessible to the average teacher of biology. Because of this, it was suggested that a brief presentation of the present status of the conservation movement might prove to be of service.

HISTORICAL

For nearly three hundred years the people of the United States have proceeded on the idea that the natural resources of this country are inexhaustible. We can readily understand why the pioneers did not apply conservation methods and planning to the various wilderness regions that they inhabited. The wilderness regions which are now the domain of the United States must have appeared so vast and limitless to the frontiersmen that they helped themselves lavishly and without any thought for the future generations. This was natural; but why, during the last four decades, this lavish use of the natural resources should have continued, is difficult to understand. Millions of acres of grass lands and forests have been ruthlessly destroyed. Natural grass lands were tilled; soils were overcropped; pasture lands over-grazed; millions of our trees were simply piled up and burned. The unrestricted killings of wild game by hunters of the past remains as a dark page in the history of our nation. Some varieties of wild game have become practically extinct; the abundance of others has been seriously reduced; the game fish left are but a fraction of what they were only forty years ago. Breeding places have been foolishly and in some instances ruthlessly destroyed; limiting barriers have been constructed in both our waters and on our lands.

Since 1681 there have been spasmodic efforts of conservation. In 1681, William Penn signed an ordinance which required that, in clearing land, one acre in every five should be left in trees. However, not until as late as 1873 did even the scientific men recognize the importance of conserving our natural resources. At this time the American Association for the Advancement of Science urged Congress to pass conservation measures. In 1897, the National Academy of Sciences definitely placed on their agenda a program which attempted to educate the general public as well as the legislature concerning the increasing necessity for conservation.

In 1891, Congress passed an act giving the president authority to withdraw areas of the public domain as forest reserves. Before his term had expired, President Harrison had set aside 13,000,000 acres as forest reservations. President Cleveland withdrew 21,000,000 additional acres. Theodore Roosevelt increased the forest reservations to more than 100,000,000 acres. Together with other types of land possessing natural resources, by 1911 Theodore Roosevelt had increased the land reservations to 234,000,000 acres. Franklin D. Roosevelt, with the aid of the unemployed men of the country, has already accomplished much in improving the quality of our public domain. Trails, fire lanes, and highways have been built by the Civilian Conservation Corps. These agencies have removed dead timber and debris, and thus reduced fire hazards; huge tracts of burnt-over areas have been replanted; the public parks, both national and state have been made more accessible to the public. Soil erosion projects are now in progress; a part of the prairies that were so foolishly tilled are now being put back into grasslands; dams and reservoirs are being built to prevent soil erosions and floods.

The public domain today consists of almost 300,000,000 acres. These lands contain almost every type of natural resource. Some of them are timber, grasslands, coal, oil, gas, phosphate, nitrate, potash, gold, silver, quicksilver and helium. Power sites, public water, reservoirs, dams, fisheries, wild game reserves, and Indian reservations have been developed.

Before we begin a study of the problems of conservation let us be certain that we know what conservation means. It does not mean restriction from all use; it does mean the elimination of waste in the use of our natural resources. In just two words, conservation can be defined as *wise use*. The government, with

the aid of its public domain and in cooperation with Universities and Scientific Societies, strives to set an example of how to use our natural resources wisely, hoping that private owners both large and small, will do likewise. Sometimes the government finds it feasible to control the conservation program of parts of the private domain.

FORESTS

The virgin forest area in 1620 has been estimated at about 820,000,000 acres. The lands believed capable of producing timber of commercial quality under a planned program is now about 495,000,000 acres. This shrinkage in forest land is a result chiefly of the extension of farm land. Farm land yields more per acre than forest land; however, the resultant forest depletion has produced many serious problems. Some of these problems are decreased wood supply, diminished rainfall, insufficient watershed protection, limited recreational lands, and depleted wild life.

The history of the lumbering industry has been a continual movement from exploited areas to relatively virgin areas until the last major forests not in the public domain have been drawn upon. There is a growing shortage of both the softwoods and the hardwoods. The absence of a conservation plan in the past is responsible for the high prices that now exist. This shortage is affecting the culture traits of the American people. As the people have developed distinct styles in wooden furniture and architecture, they have increased their demand for the use of high quality hardwoods. Much of this culture is no longer within the reach of the average American citizen. Another penalty we have paid and are still paying because of insufficient conservation programming in our lumber industry is the decay of communities that follow the evacuation of lumber industry from exploited areas. The rise and decline of lumbering in Michigan and Wisconsin are good examples of this. This is not conducive to stability within the state and the nation.

The movement of the lumber industry from exploited areas to relatively virgin areas has not only left a decreasing wood supply and demoralized communities but the denuding of the forests has also decreased the rainfall. Although this explanation of decreased rainfall has never been definitely established, the incomplete evidence available leads many to believe that deforestation affects rainfall. The felling of vast areas of forest cover has, however, decreased watershed protection. Forests retard

the rate at which snow melts and the run off of water during heavy rains. A well covered forest allows for a greater quantity of water to seep into the ground, and tends to decrease flood and prevent wholesale drying up of bodies of water. The floods and droughts of recent years are the rightful heritage of a people who have exploited their forests for nearly three hundred years.

An adequate program of forest conservation includes the following services: protection against forest fires; fungi and insect control; government controlled logging operation and a sustained-yield forest; education toward proper utilization of woods; wood preservatives; a balance in nature; forest planting; and a generously supported research program.

During the last decade there has been a yearly average of nearly 160,000 fires reported for the entire nation, with an annual destruction of approximately 64,000 square miles. This is between 6 and 7% of the total forest area; fortunately, a large proportion of the fire is on previously burned land.

The influences of a burned-over forest are many. The growth of the surviving trees is seriously retarded; trees with fire scars become more highly susceptible to disease, as the scars furnish a more fertile area for fungi and insects; the composition of the forest frequently undergoes a change: jack-pine, aspen, ferns, scrub oak, and fire cherry rapidly replace the burnt down white pine, oak, and maple. Added to this are decreased watershed protection and the destruction of wild game.

Over 90% of the forest fires are due to the carelessness of man. Some of the causes in their order of importance are: smokers, incendiarism, the burning of debris, railroads, campers, and lumbering. Some fires are due to lightning.

To keep forest fires at a minimum a thorough system of patrol and inspection in and near forest areas is required. The government must insist that lumbering camps pile and burn with care the slash created by clean logging; that railroad locomotives be equipped with spark arresters; that brush burning be done only under government permit; that the public be educated regarding the danger of careless smoking habits and the necessity for proper camping practices. The government has developed an efficient system of detecting and suppressing fires. The most important single item in this system is the "lookout tower." Other aids are accurate maps, good trails, roads, telephone system, fire-departments, and well-trained forest rangers. In some states, such as California, every male citizen while

touring the state must carry with him an ax and shovel. When within reach of a fire he is expected to help fight that fire. In this way every adult male citizen is a potential fire-fighter.

Although much has been done in fire-protection, about one-third of our forests is still under no protection. The national government has succeeded in developing an efficient system of fire detection and suppression. In a recent five year period the ratio of actual to allowable burn in our national forests has been 1:1. For the same period in private and state forests of our South the ratio was 1:14. It is clear that forest fires must be reduced, for they constitute the chief obstacle to the satisfactory solution of nearly every problem in forest conservation. The prevention of forest fires is a social problem; railroads, lumbering camps, government, and the general public must cooperate in the solution of this problem.

The control of pathogenic insects and fungi, and the decrease of damage from over-grazing are important conservational measures. Some insects retard the growth of trees; others kill them. The tree-killing beetles in the lodgepole pines of western Montana has seriously lowered the timber yield in that area. Various methods to control insects are used. Sometimes chemicals are used to kill them; other times it seems more feasible to destroy the infested trees. Methods of prevention are: constant inspection to detect insects in their early stage; careful regulation and inspection of imports that might carry harmful insects; preservation of bird life; clearing of forest litter; and harvesting of mature trees.

Some kinds of fungi destroy the commercial value of trees; others kill them. The chestnut blight has caused the American chestnut to become almost extinct. No means has as yet been found for checking its spread. The white pine blister rust is another serious plant disease. The fungi spend part of their life cycle in currant and gooseberry bushes. The disease can be brought under control by burning these plants. Both of these plant diseases have been imported.

Over half of the forest land is grazed by livestock. Over-grazing seriously depletes small trees and seedlings. Hogs, for example, will eat pine seeds and the roots of the seedlings, and thus prevent restocking of the forests. Soil erosion follows this destruction of the ground cover. The national government has shown that by limiting the number of cattle per acre, and by fencing in the hogs, forest grazing can be carried on without

seriously affecting the forests. This work has been carried on within the forest ranges of our national forests. The control of over-grazing in private forests is still inadequate.

Much of our wood can be saved by more conservation methods of logging operations. The tops, branches, and stumps could be more widely used. About 23% by volume of the wood contained in the trees that are felled is lost in logging operations. Lumbering carried on in our national forests under government control has shown this to be about 50% too high.

Since the annual consumption is several times the annual growth, some sort of sustained-yield forestry is essential. A sustained-yield conservational program will guarantee wood for the future generations and put a stop to the cut-out-and-get-out type of lumbering. The sustained-yield principle involves protecting of young growth in logging operations, leaving uncut the trees that are too small to yield a profit, nourishing the trees having commercial value, preventing over-grazing, controlling of insect pests and injurious fungi, and slash disposal.

Much has already been accomplished in the utilization of wood "wastes," and in wood preservation. Sawdust and other wastes are used in the manufacture of plastic materials, dynamite, linoleum, alcohol, tannic acid, charcoal, fiber board, and paper. Preservatives, such as, creosote, and zinc chloride extend the life of timbers 3 to 18 years by preventing decay and insect attacks.

It is highly essential that a balance in nature be maintained. Coyotes, timber wolves, and mountain lions were killed in large numbers in some of our national forests. This led to an enormous increase in the number of deer. The effect of this increased number of deer feeding upon the foliage of trees was almost disastrous. A shortage of natural feed developed and scores of deer died of starvation. Before attempting to reduce the number of any kind of animal, a thorough knowledge of the position the animal occupies in the balance of nature should be determined. More studies are needed concerning the inter-relationships of animals, and of animals and plants.

The planting of trees should be a wise investment to control erosion; on land no longer suited for agriculture; on burned-over or cut-over forest lands where agriculture would not be profitable; and in prairie areas where windbreaks are needed.

Our ability to cope fully with the problems of forest conservation is due in part to our lack of knowledge along certain

lines. A larger and more effective research program is needed. There are many problems awaiting solution. These problems deal with a fuller knowledge of the feeding habits and life history of injurious insects; plant diseases; inter-relationships of animals, and of plants and animals; land classification and zoning; growing and harvesting of trees; plant breeding and selection; sustained-yield forestry; wood utilization; wood preservatives; tax problems; logging operations, and others.

Our nation no longer has an "inexhaustible" supply of virgin timber. In the future it must rely on forests grown under some form of human control.

FARM LANDS

An efficient agricultural program is one in which there is a balance between consumption and production. The population of the nation will increase probably 6,000,000 to 8,000,000 by 1950. If other factors remain constant, from 15,000,000 to 20,000,00 additional acres will be needed for agricultural purposes by 1950. If, however, the percentage of meat and milk in the diet should be increased during this time, an even larger additional acreage will be needed. A decrease in the birth rate would, on the other hand, tend to lessen the demand for milk. Although notable shifts in the diet have occurred during the last three decades, no appreciable change in the national per capita acreage requirement has occurred.

Another factor which influences the agricultural acreage of a nation are the farm exports. Although it is impossible to predict, it seems likely that there will be no great change in total exports. Although there has been a decline in wheat and pork exports, other products have increased to make up this loss.

It seems then, that an increase in population will require a few more million acres of crops by 1950. An increase in acre yield may, however, offset the need for additional acres of farm land. Improvements in agricultural technique and new developments in plant and animal breeding tend to increase the acre yield. Some of these developments that have brought about an increase in acre yield are: shifts from less productive to more productive lands; shifts from less productive to more productive crops per acre; shifts from the less productive to the more productive classes of animals per unit of feed consumed; an increase of efficiency in utilization of feed by each kind of farm animal; and a substitution of mechanical for animal power on

farms. These are a few factors that conserve feed and increase production of animal products.

It appears that the future will bring ever-increasing acre yield. This, together with a decline in birth rate, seem to indicate that the nation is unlikely to need more than a slight increase in the agricultural area.

GRASSLANDS

According to Shantz and Zon, about 38% of the total area of the United States is grassland. The dominant and characteristic plants of this type of land are the perennial grasses. Some of these grasses send their roots down as far as 8 to 10 feet. Few plants can compete with these grasses for moisture. Although grasses and sedges may constitute only one-fourth of the total species, they make up about nine-tenths of the total vegetation. These grasses withstand irregular drought periods fatal to trees, bushes, and farm crops.

With the exception of Arkansas, and parts of Louisiana, Texas, Missouri and Minnesota, all of the states which lie between the Mississippi River and our Western Mountain Ranges, consisted largely of grasslands. The only state east of the Mississippi River which was originally grassland is Illinois. The early settlers at first avoided these grasslands. They thought them unfertile because treeless. Other reasons for avoiding these regions were insufficient raw materials for building shelters, and scarcity of fuel and water. The early settlers say that the big bluestem grass grew to a height of 10-12 feet. It was impossible for them to locate their cattle except by climbing some elevation and watching for the waving of the tall grasses as the cattle walked through it.

There are seven main kinds of grasslands. The *true prairie*, consisting largely of needle grass, dropseed, bluestem, panic grass, and wild rye, extends from Manitoba to central Oklahoma, between the ninety-seventh and the ninety-eighth meridians. The *coastal prairie*, occupies a strip of land in Texas and Louisiana along the Gulf of Mexico. Bluestem and needle grass are the dominant plants. The *short grass plains* and the *mixed prairie* types lie between the Rocky Mountains and the true prairies. Grama grasses and buffalo grass are the dominants. From southwestern Texas westward into New Mexico and Arizona lie the *desert plains* grasslands. The mesquite, three-awn, and grama grasses are the dominants. California and

Lower California contain the *Pacific prairie*. The *Palouse prairie* is located in Washington, Oregon, Utah and Idaho.

Instead of using the mid-western grasslands in their original condition, much of it was turned over for crops. That portion which was not tilled was over-grazed. As a result of tilling and over-grazing these formerly rich grasslands are practically worthless today.

The effect of over-grazing is well presented in the recently published Second Report of the Science Advisory Board:

"Over-grazing has affected in all probability most of the grasslands; we have no quantitative information on this point. The results of overgrazing are principally (1) that overstocking of pastures reduces the total amount of growing vegetation and tends to exterminate certain species, (2) that plants of low edible value, or none, will replace in part the original vegetation, and (3) that, by diminution of surface cover, soil wash and wind erosion are introduced and, under the semi-arid climates of our great grazing lands, speedily assume serious proportions. It is a peculiar quality of overgrazing that, degeneration once having set in, it is very unlikely that it is stopped thereafter. In any fully stocked range an adverse season results in damage to the vegetation, which could be compensated subsequently only by a sufficiently sharp reduction in stock to give the pasture the chance to recover. As the result the carrying capacity of a large part of our range lands has declined seriously and is continuing to do so, and some of them have become nuisance areas to lands below them because the rains run off more rapidly from the sparsely covered slopes and the increased run-off carries more sediment onto the lowlands.

"The outstanding case of the third type, the regions of unbalance as to the national economy, is the Great Plains. In view of its upsetting influence on the economic situation of the country it is probably the most critical region in the United States. Any national land program will have to come to grips with the situation. It is a region of large surplus of staple crops, of highest climatic variability affecting production and of large potential increase of crop acreage, with minimum density of agricultural population and low value of permanent improvements. A comprehensive study of conditions and potentialities on the Great Plains is one of the most wanted items for national economy. A Great Plains commission could strike at the heart of the agricultural surplus problem more directly. The increase

in field area in that section in the past quarter century has been far in excess of the estimated 40,000,000 acres of present surplus crop land in the United States. The area annually harvested in the Great Plains is distinctly in excess of this amount, and the amount of land in reserve, that has been planted in boom years and may come into production again, is huge. Our wheat and barley surplus, and in large measure that of cotton, are accounted for by the Great Plains. The plowing up of the Great Plains and the release of crop land from feed production for food production throughout the country are the two primary elements that have produced and maintained agricultural unbalance in the United States. In many parts of the Great Plains the crop hazards from climatic variability are such that the establishment of socially and economically healthy communities is doubtful. Improvements in many sections are meager, population is sparse and, at present, large amounts of land are held by mortgages that are tax delinquent and tax reverted. In no part of the country could an extensive program of land retirement be initiated with equal effects on crop surplus, with as little disturbance of population and at such low cost. The proper, permanent, and balanced use of the Great Plains in the national economy is one of the most pressing problems before the nation. Its successful resolution will be a major achievement for American science and Administration."¹

The common rodents of the grasslands are: prairie dogs, ground squirrels, kangaroo rats and jack rabbits. The settlers of the grasslands attempted to kill off the coyotes, badgers, hawks, owls and snakes. As the coyotes and badgers diminished in numbers, the rodents, particularly the prairie dogs, increased in number. Today, prairie dogs ruin thousands of acres of grasslands annually, by eating grass leaves, stems and roots. Here again we see man disturbing the "balance of nature." Attempts have been made to control the prairie dogs by shooting them or by poisoning. The results have been extremely disappointing. Probably the most feasible method of control would be to re-establish the "balance of nature" by encouraging the reproduction and survival of coyotes, badgers and weasels.

The national economy demands restoration of the grasslands. Restoration must be based on careful research, conducted by the state universities of the grassland areas with the support and cooperation of the federal government.

¹ Second Report of the Science Advisory Board, Washington, D.C., 1935.

WILDLIFE

Wildlife includes all uncultivated plants and undomesticated animals. Any conservation plan for our wildlife is inseparably tied up with the land, streams, lakes, ponds, and vegetation. This means that an effective program requires supervision of large areas of land.

Our national parks and national forests provide excellent areas for the preservation of natural biotic communities. Although it is true that in the past, park rangers killed countless numbers of wolves, coyotes, and mountain lions, and thus seriously disturbed the "balance of nature," the present rangers of these vast areas leave the plant and animal life to carry on its struggle for existence unaided. Native predators are permitted to kill other animals for food.

Although we have an excellent National Park Service today, our National Park heritage is indeed a sad one. No wolves are known to exist in any of the parks in the territory of the United States; the wolverine, bobcat, and cougar are almost extinct; the bison, elk, and antelope suffer from a lack of space, the elk and bison must be fed in winter; non-native trout have been introduced in many of our streams; and many of our parks have already lost important plant and animal species.

There are many factors that have contributed to the steady decrease of wildlife. Manufacturers of firearms have overdeveloped hunting and trapping on a large scale. Manufacturers of chemicals have over-emphasized the importance of poisons and oils, as a means of insect and mammal control. Pollution of our streams and lakes have destroyed millions of fish, water fowl, and other forms. Engineers lacking biological foresight have built dams without proper runways and have thus interfered with the breeding habits of fish. Government and private agencies have frequently drained swamps, shallow rivers, and lake marshes, in order to profit by the sale of land. Many of these happen to be important breeding and feeding grounds for a large variety of ducks, geese, crane, and other birds.

To preserve and conserve our wildlife a number of measures must be taken. The practices listed above must not be permitted to continue. Closed seasons for hunters and fishermen should continue and be adequately enforced. Game sanctuaries should be established with buffer zones. No interference should take place within the sanctuary. For the larger animals, buffer zones of large size are needed, because these forms frequently wander

far from the sanctuary. A buffer zone is an area surrounding a sanctuary. Interference within the buffer zone should take place only in periods of great abundance. Continuous killing of forms such as the wolf, fox, bear, mountain lion, deer, and elk, would take place in the area surrounding the buffer zone. Such a sanctuary with its buffer zone should be at least fifty miles in diameter.

Somewhere within the sanctuary should be a check area. This check area should be used for ecological research. Here the scientist could check floral and faunal cycles and biotic balance.

Our national parks and forests should be organized on a "let nature take its course" basis. These areas need strong buffering if the species now threatened are to survive.

Wildlife management should be developed in our state parks and forests, private forests, and on our farmlands for the purpose of hunting, fishing, and recreation.

WINS \$1000 PRIZE FOR BOOK ON LIFE'S BEGINNINGS

For her book, *Biography of the Unborn*, Mrs. Margaret Shea Gilbert of Appleton, Wis., has won the \$1000 prize offered for the best manuscript on science for the layman, the Baltimore publishing house, Williams and Wilkins Company, announces.

Mrs. Gilbert, or Dr. Gilbert as she is entitled to be called because she has the degree of doctor of philosophy from Cornell University, writes with unusual authority on the subject of the beginnings of human life. She has not only studied embryology as a scientist, but two months ago became the mother of a baby girl.

Her manuscript was one of 61 entries from all parts of the world. It tells the story of the development of the human embryo through every stage from conception to birth in what is said to be "simple terms and a very pleasing style for the average reader." The idea of writing such a book first occurred to Mrs. Gilbert when she and her husband were working for their PhD. degrees at Cornell.

NEW CAVE FOURTH AS LARGE AS CARLSBAD CAVERNS EXPLORED

Labyrinthic passages comprising a cave about one-fourth as large as Carlsbad Cavern, discovered only a few days ago, were explored immediately by government rangers. The entrance is nine miles from Carlsbad, on government land, outside the Carlsbad Cavern National Park, but inside the withdrawn area.

The newly-discovered cavern is "quite dingy, containing only three sizable formations" reports Col. Thomas Bowles, superintendent of Carlsbad Caverns. The National Park Service declined to comment on the geologically possible underground connection between these caves and Carlsbad Cavern.

NATURE RECREATION IN PITTSBURGH

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I. THE EARLY NATURALISTS AT THE FORK OF THE OHIO

It is often easier to look back and wish than to look forward and plan. If a Delaware chief should return to the happy hunting ground where the Allegheny joins the Monongahela he would find no game to stalk, no forests beneath which he could gather roots for medicine, and no springs from which to quench his thirst. The music of babbling brooks would be lost in the underground drains. That the paleface should scrape the forests from the hillsides and scatter tin cans and ash heaps in their wake would be a curious sight. Great chimneys belching black smog to hide the face of the sun by day and licking the sky with yellow tongues at night might frighten him.

Today, if George Washington and Christopher Gist should report back to Governor Dinwiddie of Virginia, it would be about universities instead of Fort Duquesne or Fort Pitt. These scouts would cross the Allegheny by a steel bridge instead of on a driftwood raft. They were sent West because of their unusual powers of observation, but even they could not picture the day when people would not make "Johnny cake," raise sage for tea, remove the rough bark from the fibre of the flax with a "hackle," or pick whortle and service berries in June. The best scouts could not dream that the time would come when each family would not set aside time for apple picking, barn raising, corn husking, and spinning by the fire. Linsey-woolsey dresses were a long ways off from rayon goods. We would not wish to give up the machine age yet there was something of contentment and satisfaction in homestead days that we miss.

The Conestoga Wagoner (1818-1840) fed and bedded his horses in the public square and slept on the floor of the wayside inn—with his feet toward the fire to prevent rheumatism. As a signal of manhood he puffed his long "stogie" with no thoughts of canal boats to say nothing of airplanes. His later compatriot, the stage coach driver, would leave Pittsburgh in the morning and arrive at Ligonier for noon dinner. He was a horse naturalist and as such had horse sense. He knew the weak and strong points of horses. It took nerve and a clear head to bring a fresh

span down the Allegheny Mountains on time but this did not enable him to vision tarvia roads or gas buggies speeding sixty miles per hour.

The first settlers saw packs of 500 wolves. By 1850 a pack of 20 wolves was unusual. In 1905 it became necessary for the wolves of western Pennsylvania to travel singly or in pairs. Bill Long (1794-1880), the King of hunters in Penn's Woods slayed over 2,000 wolves. Today there are no wild wolves.¹ From the time a bounty was offered for the scalps of wolves in 1683 up to the killing of the last wolf there was probably no thought that wolves might be exterminated. A bounty was placed on the red fox in Pennsylvania (1724) when poultry arrived and on the squirrels (1794) when the cornfield became important. As late as 1885 the Pennsylvania Bounty System included hawks and owls.² A plague of mice and rats in the farmer's grain fields brought him to his senses. By exterminating mother nature's rat traps he unwittingly had disturbed the balance of nature and was destroying his own grain which meant eventually himself.

If we are to judge the future by the past there will be many more changes. Furthermore, we cannot visualize what these changes will be but from studying other civilizations we can predict that there must be *conservation of our natural resources*. Many thinking people suspect that we have not been out of the forests so long that we can entirely dispense with them. Nature areas may be a necessity for the nerves and leisure time. If nature recreation is as much a public utility as libraries, hospitals and roads it might be that we should have a nature planning board. The object of the present paper is to present the picture to date.

"Johnny Appleseed," the Missionary Naturalist

Before there were churches, schools or fruit trees, and when the people hereabouts wore buckskin coats and coonskin hats, Jonathon Chapman (1775-1847), a Harvard graduate (tradition says with honors) and his brother came to Pittsburgh.³ This lad of high school age built a log cabin (1792) on what is now the foot of Grant Street. When the covered wagons rumbled through the Allegheny Gap and along the highway from Greens-

¹ Shoemaker, Henry W., *Wolf Days in Pennsylvania*, Tribune Press, Altoona, 1914.

² *Pennsylvania Game News*, December, 1936, pp. 3-5.

³ Himrod, James Latimore, *The True Story of Johnny Appleseed*, Chicago Historical Society, 1926.

burg it was customary for the driver to pull up his horses at the watering trough in front of this four-room cabin. Johnny would bring out apples from his cellar and often times a small buckskin bag of apple seed. He realized that the pioneers would be too busy cutting trees to bother planting them and that the women and children would no longer see pink apple blossoms in the spring unless someone planted apple seeds.

"Johnny Appleseed" caught a vision. He was destined to become an itinerant missionary-naturalist, a dispenser of apple seeds. He gave away his cabin (1806), lashed his two birch-bark canoes together and started down the Ohio with a load of apple seeds for the Northwest Territory. He selected open places on loamy lands near the streams to plant his nurseries. He plodded along from cabin to cabin where, with the help of children, he planted apple seeds.

Johnny with his whiskers and long hair must have looked like a vagabond. He was dressed in an old coffee sack with holes for his arms and head. He was usually barefooted. Once he was presented with a new pair of shoes but he soon found someone who needed them more. At first he used a tin pan for a hat and also to cook mush. He carried a staff instead of a gun. He preferred to camp out using mosses and leaves for a pillow.

In spite of his rags and unkempt appearance with hair straggling to his shoulders the children would run to meet him. The boys never made fun of him. This was the biggest compliment that he could ever have had. The Indians regarded him as a medicine man and treated him kindly. The old folks welcomed him to the fireside where he offered stories and cheer and often administered to the weary and the sick. At times he would tell about Swedenborg who taught the communion of God and nature.

One time Johnny found a ranting evangelist at a revival meeting. Johnny resented the pouring of hell fire on his woodsmen friends and let it be known that he was doing good by deeds and not by empty words. If "Johnny Appleseed" saw a lame or "used-up" horse he would purchase the animal and give him away with a proviso for humane treatment. He had the reputation of being a vegetarian. He reduced the three essentials of food, raiment, and shelter to their simplest terms. He had the unusual distinction of being Pittsburgh's first naturalist and at the same time Pittsburgh's first conservationist.

For 46 years "Johnny Appleseed" practiced the virtues of an all-around naturalist. Wherever he went he was a harbinger of peace. He sowed while others reaped. He knew Audubon, Robert Dale Owen, Wm. McClure, Daniel Boone, and Lincoln.⁴ A monument to his memory exists in Mansfield, Ohio (1924), and the school children erected a monument of granite boulders in Ashland, Ohio. There is no Pittsburgh shrine built to this patron saint of nature study nor is there a bronze tablet to mark the site of his cabin. Naught remains but vague stories and legends and yet here began the story of a great American character whose name should be perpetuated. He died in Fort Wayne in 1847.

The Story of John Brashear (1840-1919)

First of all John Brashear had *good heritage*. His ancestors were Huguenots who emigrated from France to Virginia (1658). His Grandfather Smith from Massachusetts had mechanical skill and made a fine Morse telegraph instrument, also the first gyroscope in western Pennsylvania and had the first daguerreo-type and apparatus for taking pictures in Pittsburgh. It was Grandfather Smith who taught him the constellations when he was eight years old and told him about the great comet of 1843. His mother was a school teacher and his three brothers followed some kind of a physical pursuit.

John Brashear also had an *investigative mind*. He planted feathers as a boy in hopes of growing real live chickens and hung out a box to catch thunder. Squire Wampler, a clock repairer of McKeesport, brought a hand-made telescope to town and offered a view of celestial objects at a nominal charge. John was thrilled with the rings of Saturn. "I thought how nice it would be if there were a telescope or a place where the layman, boy or girl, could have a chance to look at the stars, the moon and the planets, little dreaming that in my later life I should have an opportunity to help bring this very miracle to pass."⁵

John Brashear had *limited schooling*. There were no books on the subject but he did have the will to work. He arose at 5:30 A.M. to get to the rolling mill on time. He studied on the street car to and from work, arriving home at 6 P.M. at night. He made his own tools for grinding and polishing. He worked

⁴ Pershing, Henry A., *Johnny Appleseed and His Time*, Shenan Joah Publishing House, Strasburg, Virginia, 1930.

⁵ *John A. Brashear. Autobiography of a Man Who Loved the Stars*. Edited by W. Lucien S. Caife. Published by American Society of Mechanical Engineers, 1924.

three long years to make his first telescope (1872). He stuck the telescope out the open window. "After my wife and I had enjoyed the sight we could not rest until we had called in some of the neighbors."

John Brashear was *modest*. It was not until 1876 that he "plucked up courage" enough to write to Professor Samuel Pierpont Langley asking permission to bring his glass to the observatory for advice. Langley loaned him a book which he sat up and read through that night. "That first visit to the old Allegheny Observatory had a profound effect upon all my life. It was my introduction to the larger world of science and the beginning of my friendship with men who found their greatest happiness in discovering nature's hidden truths in spite of poverty, isolation, and increasing work of body and mind."

John Brashear was *honest*. It was not long before he received a bid to make a spectroscope for the Lick Observatory (1888). Later he did work for the U. S. Naval Observatory, the Lowell Observatory, in Arizona, the Paris Observatory, Cambridge University in England, and a host of others. Nearly every observatory in America and Europe used his apparatus. This son of toil became the foremost maker of astronomical lenses of his day.

John Brashear was a *brother of mankind*. A young farmer wanted to look in the big telescope. When Brashear asked what he would like to look at he replied "Juniper." When told that the star was not visible at that time he asked to see "Satan." Brashear says "The climax came when he asked if I could show him the 'Star of Jerusalem.' I ended it by showing him the moon and some clusters, and he went home very happy."

It was the combination of these traits that brought honors. John Brashear was chosen to be the chancellor of the Western University of Pennsylvania (1901-1904). He was elected to serve with Wm. McConway and Charles M. Schwab on a committee for creating the Carnegie Institute of Technology. Ground for the first building was broken in 1905. He was made president and custodian of a quarter of a million dollars of the Educational Fund Commission of Henry Clay Frick. The interest of this fund is for the betterment of the grade schools in Pittsburgh with special reference to assisting teachers and to improve their methods of teaching. In 1915 he was appointed by Governor Brumbaugh as Pennsylvania's "most distinguished

citizen." Honorary degrees were given him by five universities.

John Brashear *gave of himself generously*. He was a member of the Boy and Girl Scouts and of the Camp Fire Girls of Allegheny County. John Brashear, as much as he loved astronomy and as greatly as he was honored by all, said and believed that "the science most worth while in this world is that of extracting sunlight from behind the clouds and scattering it over the shadowed pathways of our fellow travelers." 6000 students of Pitt knew him as "Uncle John."

Samuel Pierpont Langley (1834-1906) was born in Roxbury, Massachusetts. His father owned a telescope. As a boy young Langley devoured books of all sorts. He built a telescope in spare time and became an assistant at Harvard. At the age of 32 he was elected Professor of Astronomy and Physics at Western University of Pennsylvania and Director of the Allegheny Observatory (built in 1861). This was before the arrival of Pittsburgh's millionaires and public benefactors. Langley had no transit and no clock. He saw the need of railway time standards and obtained distinction through original researches. He was director of the observatory for twenty years (1867-1887).⁶

He was then elected Secretary of the Smithsonian Institution (1887-1906). Langley devised a flying machine heavier than air which furnished the first solution of the problem. Like Brashear, he was a lover of children. The children's room at the Smithsonian is a result of his care and attention. He had a legion of friends including Edward Everett Hale and Alexander Graham Bell.⁷

II. THE RISE OF NATURE STUDY IN THE PITTSBURGH SCHOOLS

In the 15th Annual Report of the Superintendent of Public Schools for the school year ending August 31, 1883, Superintendent George J. Luckey writes about "The New Education" (p. 41) and incorporates remarks from Charles G. Edwards of Baltimore who says that "The current of change seems to set in the direction of a knowledge of *things* rather than of *words*; and in addition to the three R's which were once supposed to constitute the sum and substance of elementary knowledge,

⁶ Brashear, John A., "Biographical Sketch of S. P. Langley," *Popular Astronomy*, Vol. XIV, 1906, 9 pp.

⁷ Smithsonian Miscellaneous Collections, Memorial Meeting. Vol. XLIX.

we have three other things to teach—to observe closely, to think justly, and to express thought correctly.”

The course of study adopted August 14, 1883 included Natural Science. *Step 1.* “Consisted of Conversational Lessons on familiar animals, with references to form, color, and prominent characteristics.” *Step 2.* “Colors, primary and secondary, to develop power of distinguishing; flowers, paper, cloth, etc., used as objects.” *Step 3.* “Conversational lessons on objects selected from animal, vegetable, and mineral kingdoms, illustrated by common specimens of each. Review of preceding steps.” *Step 4.* “Simple lessons from plant life; on buds, leaves, flowers, trees, grasses, etc.” *Step 5.* “Domestic animals; structure, size, uses to man, kind of food, etc. Anecdotes showing cunning sagacity, intelligence, etc.” *Step 6.* Human body. *Step 7.* Metals and minerals. *Step 8.* Birds. *Step 9.* Trees. *Step 10.* Food plants. *Step 11.* Laws of Health. *Step 12.* Physical Sciences. *Step 13.* Industries of Pittsburgh. *Step 14.* “Elementary Natural Philosophy completed, with text book.” The general course in the Academical Department of the High School included *Step 15.* Hygiene. *Step 16.* Biology commenced, Chemistry. *Step 17.* Biology completed. Physics. *Step 18.* Astronomy. Geology. Physical Geography. Thus it may be seen that Pittsburgh’s first course in nature study was both comprehensive and thorough.

In 1884 Wilbur Samuel Jackman graduated from Harvard which was also the Alma Mater of “Johnny Appleseed.” It was nearly a hundred years after the appearance of “Johnny Appleseed” that Superintendent Luckey gave Jackman a position to teach natural science in the Central High School.⁸ It is evident that Jackman came to a favorable environment for the cause of nature study. During his five years of teaching in Pittsburgh he wrote a plan for teaching nature study in the elementary schools. In 1889 Colonel Francis Parker invited Jackman to teach nature study at the Cook County Normal School in Illinois. Jackman advocated many of the common sense principles used today and won national reputation for his success in this great work. He considered nature study a means by which children learned the fundamentals of life.

Home gardens were first conducted by the Pittsburgh Playground Association. In 1914 School gardens were authorized

⁸ Report of Central High School for 1884-1885.

and John L. Randall was appointed director. This was principally the work of the 6th grades. In the meantime the World War broke out and Mr. Randall at the end of the first season went to Washington. Joseph Kradle, a graduate of Penn State College, is the present director of school gardens.

In 1919 the present supervisor, Dr. John A. Hollinger was assigned.⁹ In 1920 Visual Education was added. In 1928 a "loose leaf" course in Nature study and Elementary Science was prepared by a committee of teachers under the supervision of Dr. Hollinger. Wm. M. Davidson, Superintendent of Schools, speaks of it "as an essential part of the public school curriculum. Nature's claim to our sympathetic understanding is fundamental in educational processes. It is the call of life to life; the demand for intimate relationships; the challenge to human interests, and the promise of general rewards." Sixty minutes was allowed per week for the elementary schools. Dr. Hollinger's inquiry⁹ showed that there were 140 teachers giving full time to elementary science. Besides the director there were 4 supervisors, 103 in special class rooms of the elementary schools and 38 in junior high schools. There were also 21 garden teachers. In 1926 the budget was \$42,605. The Board of Education appropriates \$2,000 annually to the Carnegie Museum for the preparation of specimens and transports the 8th grade pupils to the museum three times per year. The teachers may requisition from the department of visual education such things as animal cages, aquaria, pictures, seeds, tools, slides, films, stereographs, and lanterns. Dr. Hollinger has a highly organized system which is the fruition of 50 years of growth. With the addition of such opportunities as City Parks and playgrounds, Pittsburgh has a wonderful vista in nature education for those who are strong, young, and free from the worship of textbooks and established procedure. As is apt to be true in the big industrial centers the voice of the outdoor teacher is almost that of one crying in the wilderness. The demands for a progressive outdoor program means a difficult time for the weak and inefficient teacher of elementary science. The presence of champions of the cause in closely allied organizations represents a dynamic power that is sure to keep Pittsburgh in the front ranks of nature education. Dr. Hollinger is revising the course around the out-of-doors.

⁹ Hollinger, Dr. John A. "Inquiry Concerning Department of Nature Study and Visualization" (unpublished notes), 1928.

III. NATURALISTS CLUBS

The oldest naturalist club is the Botanical Society of Western Pennsylvania,¹⁰ the first meeting being in the office of Dr. B. Burns in 1886. The records of early naturalists are apt to be scant. They come, they labor hard and earnestly under the eaves or in the remote woods, they pass away and are forgotten. Most of the members of the Botanical Society are professional men: physicians, teachers and clergymen. Professor B. H. Patterson was the first president and Wilbur S. Jackman corresponding secretary. Wm. Falconer, Superintendent of Schools, was president 1903-1906. Dr. O. E. Jennings was president 1907-1909 and has been the moving spirit of the organization over a long period of years. In Dr. Jennings's revised list, in 1906 he listed 991 species. The Society's magazine *Trillia* is an excellent medium for preserving records and the philosophy of its members. John Bright writes that "all the book learning in the world may cover only the beginning of our education, but the ability to observe is the keystone of all education." "When man is a chronic grouch he is mentally and spiritually 'out of whack.' He sits and smokes, broods, and gets grouchier every day. What this man needs is a garden."¹¹ Dr. John Adolph Shafer was primarily a field Botanist and Dr. Jennings calls him the "foremost pioneer Botanist."¹² Shafer was a charter member of the Society and went with Dr. L. N. Britton, Director of New York Botanic Garden on a Botanic Expedition to Cuba (1903). Dr. Shafer collected for the Botanic Garden (1907-1917) and was museum custodian (1904-1910).

The Audubon Society of Western Pennsylvania is also a field club and schedules bi-weekly trips. Wm. S. Thomas, a charter member and one-time president published two volumes—*Hunting Big Game with Gun and with Kodak* and *Trails and Tramps in Newfoundland and Elsewhere*.

The Nature Club of Pittsburgh (1919) possesses Na-Wak-Va Lodge at Ligonier where a six weeks' summer course is offered with credit at the University of Pittsburgh. The membership is mostly teachers in the elementary schools.

Pittsburgh has about 15 clubs directly concerned with nat-

¹⁰ Botanical Society of Western Pennsylvania Publication I. October 1910-1911. Issued Nov. 27, 1911. Publication IV. Adopted name *Trillia*, October, 1916.

¹¹ Bright, John, *Trillia*, No. V, 1915-1919, p. 28, p. 29.

¹² Jennings, O. E., *Trillia*, No. V, 1915-1919.

ural history. Whatever one's interest he can find his niche.¹³

IV. NATURE'S WEALTH CONVERTED INTO SERVICE FOR MEN

Given: the confluence of three rivers, rich coal mines, the Bessemer process, and men like Carnegie, Westinghouse, Schwab, Frick and Mellon, and you have "The Workshop of the World." Industrial giants, millionaires, and a return to the people in the form of culture is the romance of Pittsburgh. If one's hobbies are the best clues to one's character and ability the gift of a Carnegie Museum, or Frick Park, or a Mellon Institute indicates that somewhere in the giver's biography is the appreciation of natural history in action.

Andrew Carnegie (b. 1835)¹⁴ was a Scotch lad who came to Pittsburgh. The great steel master amassed an enormous fortune, and gave it away for the betterment of mankind. Born "of poor and honest parents, of good kith and kin" he believed that his ability of making "all ducks swans" was inherited from his grandfather. One of his chief enjoyments of childhood was keeping pigeons and rabbits. "My mother was always looking to home influences as the best means of keeping her two boys in the right path." Anyone who has kept rabbits knows their mathematical propensities and their reputation for multiplying. Carnegie's story of his pet rabbits has far-reaching implications and is a classical illustration of the "bent-twigg." "My first business venture was securing my companions' services for a season as an employer, the compensation being that the young rabbits, when such came, should be named after them. The Saturday holiday was generally spent by my flock in gathering food for the rabbits. My conscience reproves me today, looking back, when I think of the hard bargain I drove with my young playmates, many of whom were content to gather dandelions and clover for a whole season with me, conditioned upon this unique reward—the poorest return ever made to labor. Alas! What else had I to offer them! Not a penny."

When Carnegie came to America at the age of 13 he had read little except about Wallace Bruce and Robert Burns. In trying circumstances he would ask—what would Wallace have done? Carnegie worked in a bobbin factory, was later a mes-

¹³ Vinal, W. G., *Nature Recreation in Pittsburgh*, Tabulated Information, Bureau of Recreation, Department of Public Works, City Hall.

¹⁴ *Autobiography of Andrew Carnegie*, Houghton Mifflin, 1920.

senger boy, and then a railroad clerk. He considered work an opportunity and not something to be avoided. I wish that Pittsburgh boys today knew Bruce and Burns or that they would ask—What would Johnny Appleseed or John Brashear have done? Pittsburgh is fortunate in having nature heroes. Pittsburgh is negligent in worshipping her nature heroes.

Carnegie was a disciple of Herbert Spencer. He says "Few men have wished to know another man more strongly than I to know Herbert Spencer, for seldom has one been more deeply indebted than I to him and to Darwin after reading their works.—Not only had I got rid of theology and the supernatural, but I had found the truth of evolution" (p. 338). Carnegie was a fellow traveler with Spencer on the *Servia* from Liverpool to New York (1882). The Philosopher visited Carnegie at Pittsburgh and he in return usually visited Spencer when he went to England. Carnegie expressed his philosophy when he said "One truth I see, Franklin was right. The highest worship of God is service to Man."

The progenitors of Henry Clay Frick (b. 1849) came to America in search of religious freedom. He was a "delicate child," spent his boyhood on a farm, and studied McGuffey's reader, Mitchell's geography, and Ray's arithmetic in the district school. Tradition has it that he received his share of "hickory oil." This did not spoil his interest in the common schools for he did the unusual thing of leaving a large gift for the improvement of the Pittsburgh public school system (1909). He also gave to the city of Pittsburgh 157 acres as a public park, free to the people and in trust the income of two million for its maintenance.¹⁵ The trustees must have foreseen the days of speed demons when they specified that no boulevards were to be built through the park. Frick's outdoor ancestors and appreciation of a country education made possible Pittsburgh's most naturalistic park where her citizens are so well served in nature recreation.

When one becomes acquainted with the Mellon Institute for Industrial Research (1913) he can be sure that somewhere Andrew W. Mellon (1855-1937) had received a love for scientific procedure. His father was a Scot and was born in the North of Ireland. Andrew W. Mellon read "The Chemistry of Commerce" by Robert Kennedy Duncan (d. 1914) a professor of chemistry. This resulted in the founding of the Institute

¹⁵ Harvey, George, *Henry Clay Frick—The Man*, Chas. Scribner's Sons, 1928.

which is a memorial to Judge Thomas Mellon (1813-1908) a graduate of the University of Pittsburgh, (1837) and a disciple of "Poor Richard." The Mellon Institute is an outstanding example of philanthropy and civic idealism and is to industry what the Rockefeller Institute is to medicine. Its aim is to conduct skilled research in chemistry, physics, and biology as an aid to industry. The manufacturer donates a Fellowship (approximately \$6000) which pays the salary of the Fellow. The Institute gives a room, equipment, library, and supervision. The result belongs to the donor. This temple of science with its imposing 62 columns of 60-ton Indiana limestone has influence on bread, fur, glass, sugar, paper, insulation, milk products, soap, medicine, and the thousand and one things of every day life. When one realizes that it has taken thirty years to transfer rayon from the laboratory to its present industrial scale he can multiply such an effort by the products of industry and the eons of years to come and thereby obtain a picture of the sum of human knowledge and the service to mankind that may result. If someone could visualize such an institution for research in nature education and nature recreation whereby men could obtain and produce similar philosophy of life an inestimable good might result.

V. THE UNIVERSITY OF PITTSBURGH AND THE NATURE MOVEMENT

Reverend Robert Bruce was elected principal and professor of Natural Philosophy, Chemistry and Mathematics at the Western University of Pennsylvania (1822). Students today might see little relation between Bruce's Sacred Natural History and such movements as school gardening, camp nature experiences, playground nature recreation, and conservation which have their distinct philosophies. Natural philosophy has been a growth and each phase has its analogue in the past.

Doctor George Woods, Chancellor of Western University (1859-1880) was born in North Yarmouth, Massachusetts and had a hobby of collecting minerals and shells. However, as late as 1891-1892 no biology was mentioned in the University Catalog. By 1896 the biological sciences consisted of anatomy in the junior year, and Packard's Zoology and Mivart's "The Cat" in the senior year. In 1903-1904 there were invertebrate and vertebrate zoology courses. In botany and bacteriology trips were taken "to study different plant societies."

Nature study as we recognize it today began at the University in 1907 when Professor John Calvin Fetterman gave Saturday Morning courses (9:00-12:00) for public school teachers,¹⁶ in the form of a series of lectures on "Common aspects of zoological, botanical and physiographic nature." In 1908-1909 the Department of Psychology and Education in conjunction with the Pittsburgh Playground Association gave courses for Playground teachers. George E. Johnson came as director of the Association and was appointed at the University as Professor of Play (1910). He gave courses during the three terms which dealt with adult recreation as well as child nature. Nature study began in this setting at the School of Education (1910) with Mrs. Horace Greeley Carmalt as teacher. She not only gave a "course in Methods in Nature Study" which included a "careful study of the latest textbooks" but also gave methods courses in history, language, and eye and hand training. John L. Randall, Supervisor, although not listed on the college faculty gave a Saturday Morning course on "Nature Interests" with one credit.¹⁷ His work must have been highly successful for by 1913-1914 the catalog not only included some 36 courses in biology but under the heading Agricultural Education there appeared seven courses on Nature Study Teaching by John L. Randall, Assistant Professor of Agricultural Education (1912).¹⁸ These were given in the School of Education and included a course in "Home Gardening and Agriculture for Rural Schools." Opportunity for practical laboratory work was offered in the greenhouse of the Pittsburgh Playground Association.

Dr. Otto E. Jennings taught botany at Ohio State (1901-1909) and came to the School of Mines of the University of Pittsburgh as Professor of Paleobotany in 1911. In 1912 he began classes in ecology and has always had the reputation of being a keen leader in the field and probably has the best knowledge of outdoor Western Pennsylvania. As Museum man, professor at the University, and President of the Botany Club, every nature leader comes under his influence.

Dr. Samuel H. Williams began the art of taxidermy when 18 years old. Close association with an older brother gave him an early interest in nature. A student of Doctor Jennings, Doctor Williams has also had a rich experience in travel. This com-

¹⁶ Annual Catalogs, University of Pittsburgh: 1906-1907, p. 118; 1907-1908, p. 180; 1908-1909, pp. 123-124.

¹⁷ General Catalog, 1910-1911, p. 281.

¹⁸ University of Pittsburgh Bulletin, Vol. 9, No. 1, p. 292.

bined with his work at Slippery Rock State Teachers College and being Associate Director of the University Lake Laboratory at Presque Isle has enabled him to bring forth his interesting nature book *The Living World*.¹⁹ This book is an ambitious but successful unification of the field of nature study whether for general culture or for the leader.

The Nature study classes are now held in the "Cathedral of Learning," a 29 story building built at a cost of seven million dollars.

VI. THE PITTSBURGH PARKS AND NATURE STUDY

Schenley Park was donated in 1889 by Mrs. Mary E. Schenley, daughter of General James O'Hara. Frick Park was added in 1920. If Pittsburgh was tardy in establishing parks the city was among the first to have a park naturalist and has been a leader in the cultural use of the parks.

As early as the fall of 1911 Ornithological work was installed "regarding the preservation of the life of our native birds."²⁰ Frederick S. Webster was appointed "Ornithologist of the Bureau of Parks" by the city council. In the four parks, Schenley, Highland, Riverview and McKinley he reported nests of 75 robins, 30 chipping sparrows, 15 wood thrush, 4 blue birds, 2 turtle doves, etc. This was an early census of birds nesting in given areas and it would make an interesting comparison to take a census twenty-five years afterwards (1938) in the same areas. The ornithologist also inspected and repaired bird boxes, put up feeding stations, gathered knowledge about topography, vegetation, character of soil, and trapped English sparrows. No money, except street car expenses, was allowed in 1914 and the position of park ornithologist, after four years was abandoned in 1915.

William Falconer (1850-1928) was born in Scotland and studied in the Royal Horticultural School at Kew. In this country he was Superintendent of the Botanical Gardens at Harvard. Then he managed the estate of Charles A. Dana of the New York *Sun*. While there he edited a horticultural paper *Gardening*. In 1896 he came to Pittsburgh as Superintendent of Schenley Park (1896-1903) and soon after was made Superintendent of city parks. It was Falconer who developed the Easter Flower Show (1910) and the Annual Chrysanthemum Show into occasions of public importance.

¹⁹ Williams, Samuel H., *The Living World*, 704 pp., Ill. \$3.60. The Macmillan Company, 1937.

²⁰ Annual Reports, Bureau of Parks, 1913, pp. 51-54.

The Phipps Conservatory was presented to the city in 1893 by Henry Phipps who stipulated that it would be open on Sundays. The Presbyterian ministers were indignant that God's handiwork should be exhibited on the Lord's Day or possibly they considered that the rare plants which had been sent from the Chicago's World Fair (1893) were inventions of the devil. Horticulture is no longer a monopoly of scientists and even ministers have been known to show genuine interest in the Easter Flower Show.

Amateur horticultural interest was further stimulated by Mr. Phipps who desired that the thousands of pupils from the High Schools be benefited in botanical work. He established the Phipps School of Botany (1901), a building unique in park structure and park life, where first year high school students reported weekly.²¹ In the spring term of 1913 the School of Botany was from April 10 to May 28. It required the services of four instructors. The School of Botany was adjacent to the Conservatory where the flowers and plants were provided for study. The School was abandoned because of the cost of transporting the pupils. It is now the headquarters of the Bureau of Parks, who are really squatters.

The Pittsburgh Park and Playground Society aims "to encourage the welfare and attractive development of parks and playgrounds." One of their recent efforts to make gardening more interesting has been the installing of garden lighting effects at the Conservatory. The Garden Club of Allegheny County made possible the present materials used in the Cloister Garden—a reproduction of a XVII Century Garden. "One of the World's finest in a truly natural setting" has the collection of Charles D. Armstrong (1861–1935), for 16 years president of the Citizens Committee on City Planning. These are but few of the examples of nature consciousness.

The Park Naturalists with special training in nature study are at Frick (1934), Schenley (1936), and Riverview Parks (1936). They conduct nature walks and give lectures free of charge. The success of this service was "instantaneous." At Frick and Riverview, community clubs have been formed which guarantee that these parks are a matter of neighborhood concern, an important policy in modern park development. These two parks have resident naturalists and park museums where local

²¹ Annual Reports, Bureau of Parks, City of Pittsburgh, 1914, p. 32.

materials are on display and where the clubs hold weekly meetings.

One of the chief pace-setters in "the more beautiful Pittsburgh movement" is Ralph E. Griswold, Superintendent of the Bureau of Parks. A graduate of Cornell, with practical landscape experience in Europe and in the Metropolitan Parks at Cleveland, Mr. Griswold is a naturalist at heart. His plan for stocking the Schenley Park Lake with sunfish, catfish, and yellow perch for the youngsters is typical of his ability to visualize and think in the large. He plans that the children wear buttons which signify their membership in some organization like the Junior Izaak Walton League. The button is their fishing license. The privilege of fishing lasts so long as they obey the natural laws of conservation which are made clear to them from the beginning. Mr. Griswold is acting on the principle that if youth grows up in ignorance of the conservation movement, there will be no guarantee of the perpetuation of conservation. Conservation and its reasonableness must be in one's heart and not in the statute books alone.

Up to 1914 the parks of Pittsburgh totaled 1322 acres. The National Conservation program inaugurated by Franklin D. Roosevelt initiated an era of new thinking in regional planning. The Laurel Ridge Recreation Demonstration Project, begun in 1935, included 5000 acres of submarginal land which is adjacent to the 7000 acre Kooser Lake State Forest, in the Western Part of Somerset County, in the foothills of the Allegheny Mountains. Twelve thousand acres of forest and game preserve is surely a "Challenge of the New Leisure." In the summer of 1937 the activities of the area will be operated by the Pittsburgh Y.M.C.A., which is the agent for the Group Work Division of the Federation of Social Agencies. This activity will include 125 children and 25 family groups at one time. Instead of the area being measured by so many beaver pelts, or by board feet of lumber, or by bushels of potatoes, the success of the project will be measured by the yardstick of happiness, health, and nerves which are so fundamental to human needs in a congested district.

Forest Recreation is a forest product. Human engineering in a 12,000 acre tract demands leadership of the highest type. Because of mismanagement in the past, Pittsburghers now have to go sixty miles to get strength from nature. One forest fire and Pittsburgh families would have to go over the next ridge

to see nature as it should be. Ignorant campers can contaminate the streams and litter the hillsides as they have at home. Camping is an art. Washington and Gist knew it. Camping also means strength from nature. To preserve strength one must preserve nature. Such was the philosophy of Johnny Appleseed. Nature must be available to the low-income industrial families. As a worker in a rolling mill and through the smoke of Pittsburgh, John Brashear found nature recreation. He was an exception. Most of us have to be shown the way. The success of this outdoor school room will depend on outdoor leadership. Such leaders must be trained and the responsibility evidently lies with the Federation of Social Agencies. The University of Pittsburgh has built a Cathedral of Learning. It has done notable work in training nature leaders. This training must be extended to the "Cathedral of the Woods."

VII. THE CARNEGIE MUSEUM, A VITAL SOURCE OF NATURE RECREATION

The Carnegie Institute is a combination of library, art gallery, music auditorium, and natural history museum (1896) costing with its endowment 25 million dollars and covering 4 acres of ground. If the schools are the heart, and the parks the left arm, the Carnegie Museum is the right arm of nature education and a strong arm at that. One must know the story of the several parts of the nature movement in order to conceive it as a whole.

A "Nature Contest" has existed in some form since the forming of the museum (1896). At first the "Prize Essay Competition" (1896-1904) was limited to high schools. The essays were to be in the form of a letter to a friend describing a trip through the museum. The Board of Judges included a bishop, a college president, the city controller, and a "distinguished member of the bar." There were 111 essays under anonymous names, the real names not being announced until the final public meeting. At this time W. J. Holland, Chancellor of the Western University of Pennsylvania and Director of the Museum delivered an address. "It is one thing to have studied about the measles in a book, it is another thing to have them—Mont Blanc cannot be transported and dumped behind a high school for the enlightenment of the pupils—A Museum is an encyclopedia in which, instead of pictures, we have the objects themselves—Our ambition is to promote the education of the people and

especially of the young people." George J. Luckey, Superintendent of Schools responded, emphasizing his belief that education of children is "no longer confined to the three R's, not to books alone."

According to the "Annals of the Carnegie Museum" the second year title was "The Four Things that Interested Me Most in the Carnegie Museum, and Why." It may be surprising to know that 52 chose the Flamingoes and Mummies were a close second with 50 writers. The third contest was on "Showing a Friend through the Carnegie Museum" which brought out the criticism of the judges that many of the essays were nothing more than catalogs, even to the copying of Greek words. "What I learned from five objects in the Carnegie Museum" (1899), "An Afternoon at Carnegie Museum" (1900), and "The Animals of the Past," as illustrated by the collections in the Carnegie Museum (1901) were often scrappy in style, bookish, and without originality even to the forgetting of quotation marks. By the fifth year there were six committees totaling 31 judges and on the eighth year there was an avalanche of 1743 essays which must have been some "chore" for the judges. The contest was interrupted in 1905 when the museum was closed to the public as its materials were moved to the new building of the institute. Similar work was inaugurated in Chicago and Philadelphia. The contest was resumed by the Department of Fine Arts and the Museum in 1922. A "Study List for Nature Contest" to be held at the Carnegie Institute, May 15, 1937, by the Biology Section of Western Pennsylvania Educational Association was published. Both elementary and High Schools enter the contest. Although not approved by Progressive Education Associations prizes are offered.

The Andrew Carnegie Naturalists' Club consists of boys. According to the museum report for 1899 there were over 100 in the club and by 1900 there were 200 members. Prizes such as \$5.00 for the best collection of shells of Allegheny County, minerals \$10.00, and insects \$20.00 were offered. The club was spoken of in 1912 for the last time.

Dr. Wm. J. Holland, the first director of the Carnegie Museum, is best known outside of Pittsburgh for his popular *Butterfly Book* (1898) and the *Moth Book*. Both books are replete in digressions in way of gems of English literature and entertaining stories. In the preface of the *Butterfly Book* he says that "One of the commonest pursuits of boyhood is the

formation of a collection of insects. The career of almost every naturalist of renown has been marked in its early stages by a propensity to collect these lower, yet most interesting and instructive, forms of animal life." Its 48 color plates reproduced by the 3 color printing process marks the beginning of colored plates in books and the book is also an early attempt to popularize butterflies. The year that Holland's *Butterfly Book* appeared is a milestone in the production of well-known nature books, namely: Mabel Osgood Wright's *Four Footed Americans*, Neltje Blanchan's *Bird Neighbors*, Ernest Thompson Seton's *Wild Animals I Have Known*, Bradford Torrey's *A World of Green Hills*, Charles C. Abbott's *Clear Skies and Cloudy*, and Charles M. Skinner's *Do Nothing Days*.

George Miksch Sutton, former Curator of Birds at the Carnegie Museum and one time State Ornithologist is now at Cornell University. As a young man he prepared illustrations for *Birds of Western Pennsylvania*, by W. E. Clyde Todd. Sutton discovered the eggs of the Harris Sparrow (1931) in the Hudson Bay region which was the last North American bird whose eggs remained unknown. He is best known as a painter of birds in their natural surroundings. His water colors made within the shadow of the Arctic Circle of willow ptarmigan, the blue goose, and the snowy owl, with ice and snow for backgrounds of the tundra and an arctic sky are striking productions.

Space does not permit further elaboration of the famous naturalists who have served on the staff of the Carnegie Museum.

VIII. THE BUREAU OF RECREATION also has a past and a cog in the machinery of Pittsburgh's Nature offering. Mention has already been made about the part the organization leaders played at the University. The first playground was at Forbes School Yard (1896) under the sponsorship of the Pittsburgh Playground Association, Miss Beulah Z. Kennard, Chairman. In the early years they had excursion days which took the form of wholesale picnics, and involved problems of safety and transportation. In 1901 Pittsburgh's "Recreation Parks" or vacation schools began. By 1906 the recreation grounds had increased to seven. Up to this time the activities had been mostly under volunteer leadership. George E. Johnston of Hyde Park, Massachusetts had had considerable experience with playgrounds and with vacation schools and was invited to head up the work

(1906-1912). In 1907 there were 10 school yard playgrounds, 9 vacation schools, 5 city playgrounds, and 6 so-called Recreation Parks with an appropriation of over \$50,000.²² January 1915 the City took over the work of the Association. By 1917 there were 7 yearly playgrounds and 25 summer playgrounds with an appropriation of \$122,500.

January 12, 1911 Professor Harry L. Wieand told the Botanical Society of Western Pennsylvania about his work with Nature Study and Vegetable Gardens in connection with the Pittsburgh Playgrounds. In 1909 he tried to find "What the child's instincts were—what he wanted to study in nature, what he wanted to collect," etc. He thought that indiscriminate collecting should be discouraged.

The Glenshaw Civic Club conceived the idea of beautifying the surroundings by working through the children. For six years (1904-1910) it offered seeds and prizes. At first the project was carried on in school gardens and later in home gardens, "although dogs and the 'almighty chicken' had wrought havoc in some cases, some of the flower-beds were good, often neatly fenced off."

Since the Public Schools took over the garden work the Bureau of Recreation, unfortunately, has done little in the way of nature recreation.

IX. PRIVATE AND SOCIAL AGENCIES AND NATURE RECREATION

Lillian Home. In November, 1902, Charles L. Taylor purchased 65 acres at Valencia, Butler County.²³ The area is reserved for the summer outing work of the Kingsley House Association for children of the city's grim alleys. It has a capacity for 250 and includes all ages from infants to grandmothers. "The impulse to better things and the firmer grip on life which comes with a love of God's Out-of-Doors, cannot be reduced to statistics." Emma Farms is a similar project under the auspices of the Kaufmann Settlement House.

Chatham Village is Pittsburgh's model one and one-half million dollar housing project. The Buhl Foundation had dedicated 27 acres of hillside woodland as a permanent area for nature recreation for 197 families. The rent averages \$10 per room per month which includes lawn and garden maintenance

²² *Pittsburgh Index*, Jan. 21, 1911.

²³ *Pittsburgh Index*, March 20, 1911, p. 6.

and garden lighting. There are two miles of trails and also picnic nooks in the woodland. Under conventional practice the hillside would have been denuded, cut into small bench-lots, and the steepest parts abandoned to tin cans and gulleying. The project is a model for any community developing in the hills.

The Homestead Area has a population of 50,000. Its welfare also depends on the Steel Works. A year ago it had no recreation area. The Homestead Recreation Reservation consisted of reclaiming an 80-acre tract of land including an "impossible" valley. The 20×60 foot building built in 1903 during a smallpox epidemic has been converted into a field house. Nearby an outdoor theatre has been built in an abandoned quarry. Two hundred children per day, 90% of whom walk, come into this "Lorna Doone Valley" for five successive days. They are given dramatics, nature recreation, and other activities.

X. TAKE A LEAF OUT OF PITTSBURGH'S NATURE BOOK

Pittsburgh has some eight chapters in its nature book. Every chapter represents a potent factor which is contributing to the nature movement. They represent an armor of defense which is only acquired by continuous thinking and planning. The general public has confidence in the integrity of each of the eight organized efforts. Pittsburgh has done better than most cities, but not enough. Now steel reduces the work week from 48 to 40 hours, eight more hours per person per week or one extra full day for leisure activities. Carnegie Steel alone with 100,000 employees adds 41,600,000 leisure hours per year. Adult and family recreation leaps into prominence. Parks, camping, picnic grounds, and home gardens take on a new significance.

It is only through a coordinated effort that the great opportunity of nature recreation can be made effective. In the "Johnny Appleseed" parish squalid tenements and bleak paving stones have crowded out the last vestige of an apple blossom. Pittsburgh's Roaring Fourth is rank mockery. On Grant's Hill there is sore need for apple blossoms to cheer the depressed and lowly. Not a sunflower nor a morning glory cheers a "Cabin door" in Pittsburgh Harlem. As long as the steep hillsides remain denuded and littered with tin cans—as long as Pittsburgh children are hungry for the sight of apple blossoms and green pastures—for that time there shall be tireless effort to satisfy that nature hunger.

COMPARISON OF THE SEMI-LOGARITHMIC WITH THE CUMULATIVE CHAIN-PERCENTAGE CHART

BY C. B. ALLEN

Western Reserve University, Cleveland, Ohio

The semi-logarithmic chart and the cumulative chain-percentage chart are rate-of-change charts designed to depict trend or growth rather than status or absolute change. Under certain conditions they are quite similar, but they may differ considerably. The differences are due to certain variable inconsistencies in the method of cumulative chain-percentages which are not found in the semi-logarithmic method.

The semi-logarithmic chart in its most common form has a logarithmic scale along the vertical axis, and an ordinary scale divided into equal intervals along the horizontal axis. The former is used to scale the magnitudes of the changing quantities while the latter marks off the equal units of time during which the changes took place. Semi-logarithmic charts may be constructed easily in either of two ways; by plotting the logarithms of the numbers on ordinary graph paper, or by plotting the original numbers on paper specially ruled in logarithmic fashion as in Figure 1.

Probably the greatest advantage of the semi-logarithmic chart is that a curve representing a constant rate of increase, measured at equal intervals of time, is a straight line rather than a complex curve. The relative slope of a segment of a semi-logarithmic curve indicates the rate of change. Several other characteristics and advantages not described here make this form of chart superior to ordinary charts for showing relative growth by means of curves.¹

The cumulative chain-percentage chart has equal scale divisions along each axis. The vertical scale represents per cents of increase. The horizontal scale is the same as that of the semi-logarithmic chart. The chief difference between the two scales, then, is in their vertical scales. The semi-logarithmic chart expresses the magnitude of the changes as logarithms of the

¹ For a detailed discussion of a semi-logarithmic chart see Karsten, Karl G., *Charts and Graphs*. New York: Prentice-Hall Inc., 1923, pp. 366-425. Or Secrist, Horace, *Readings and Problems in Statistical Methods*. Macmillan, 1921, pp. 282-305. For an outline of the characteristics of logarithmic charts see: Allen, C. B. "Logarithmic Charts" *Educational Administration and Supervision*, 20: 583-90 (November 1934).

numbers, while the other pictures these changes in terms of cumulated totals of the per cents of increase of the successive steps. Both types are ratio charts in the sense that they express the changes relatively.

The chain-percentage chart is more easily understood by the general reader because it is based upon per cents rather than logarithms. However, the amount of work involved in calculating and plotting the cumulated percentages is somewhat greater than that of plotting the original figures on logarithmically-ruled paper.

TABLE 1

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Original numbers	Original numbers expressed as per cents	Absolute increases of (1)	Chain-percentages: Increases in (3) based upon (1)	Cumulative chain-percentages from (4)	Logarithms of the original numbers (1)	Differences of logarithms in (6)	Antilogarithms of the differences of logarithms (7)
10	100%		0.00%	0.00%	1.0000		
11	110	1	10.00	10.00	1.0414	.0414	1.100
15	150	4	36.36	46.36	1.1761	.1347	1.363
18	180	3	20.00	66.36	1.2553	.0792	1.200
20	200	2	11.11	77.47	1.3010	.0457	1.111
40	400	20	100.00	177.47	1.6021	.3011	2.000
50	500	10	25.00	202.47	1.6990	.0969	1.250
60	600	10	20.00	222.47	1.7782	.0792	1.200
80	800	20	33.33	255.80	1.9031	.1249	1.332
81	810	1	1.25	257.05	1.9085	.0054	1.013
85	850	4	4.94	261.99	1.9294	.0209	1.049
88	880	3	3.53	265.52	1.9445	.0151	1.035
90	900	2	2.27	267.79	1.9542	.0097	1.023
95	950	5	5.56	273.35	1.9777	.0235	1.056
100	1000	5	5.26	278.61	2.0000	.0223	1.053

In Table 1, are given hypothetical data together with certain derivatives. An imaginary example is used instead of an actual one in order to emphasize some of the differences between the two methods. Column (1) contains the absolute numbers upon which the illustrative curves are based. In Column (2) each successive item of Column (1) is expressed as a per cent of the base figure 10. Column (3) shows the absolute increase of the successive numbers in Column (1). The quantities in (4) express these increments as per cents. Percentages of increase or decrease in a succession such as those in (4) are called chain-percentages.² Column (5) gives the cumulative totals of (4). The

² Chain-percentages are also called chain-relatives, and link-percentages. See Karsten, *op. cit.* pp. 307, 385, 419.

figures in Column (5) are the cumulative chain-percentages used in constructing the curve in Figure 1.

Column (6) contains the logarithms of the original numbers in (1). Column (7) states the differences between the successive

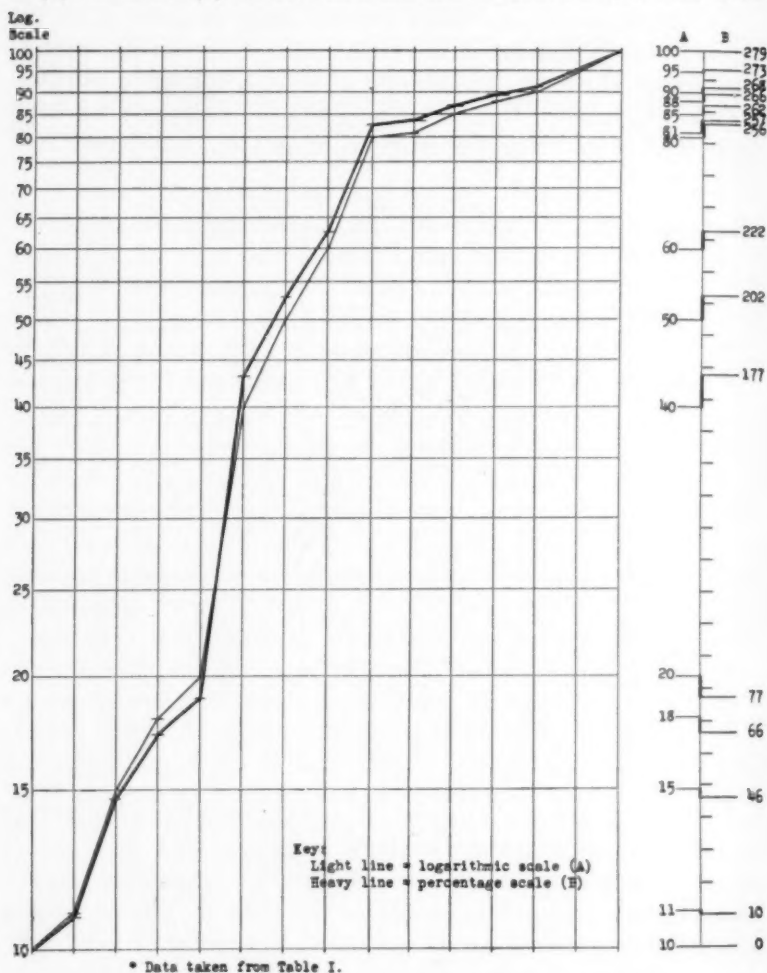


FIG. 1. Comparison of a semi-logarithmic chart with a cumulative chain-percentage chart.*

logarithms of (6), and in (8) are found the antilogarithms (actual numbers) of the differences in (7).

The light-line curve in Figure 1 is the result of plotting the original numbers of Column (1) of Table 1 on the semi-logarithmic ruling which forms the background of the chart. The

actual positions of the ordinate points are shown in the supplementary scale A to the right of the chart.

The heavy-line curve represents the cumulative chain-percentages of Column (5), Table 1, plotted independent of the vertical logarithmic scale of the chart which was used to locate the points of the semi-logarithmic curve. The position of the ordinate points of the percentage curve are shown in the supplementary scale B. The total number of units on the percentage scale is equal to the total of the percentages of increase minus the decreases or *vice versa*. In the particular illustration given in Figure 1 all changes are increases, hence the range of the curve equals the sum of the percentage increases of the respective intervals; or 278.61 as shown in Column (5) of Table 1.

To facilitate comparison, the two curves in Figure 1 are drawn so that their limits coincide. It is evident that the two curves are similar in their general aspects, but differ considerably in the location of particular points. The magnitudes of these differences are indicated by the short heavy lines on the vertical line separating supplementary scales A and B. The reasons for these inconsistencies may be clarified by additional examples.

If on semi-logarithmic paper a line is drawn connecting absolute values of, say, 10, 20, 40, 80, the curve will be a straight line because each succeeding number of the series is equal to twice the preceding one, and therefore represents a uniform increase of 100% for each interval—a constant rate of increase. The difference between the logarithms of any two of the above consecutive numbers is .30103. If another number, say 15, falls between 10 and 20, the distance from 10 to 20 on the logarithmic scale is unchanged; in fact the position of 10 and 20 would continue to remain the same regardless of the number or magnitude of intervening figures such as 12, 14, 18, etc., which might occur in the series. In other words, the sum of the differences between the logarithms of successive numbers in any given series between the limits of 10 and 20 will also be .30103.

On a cumulative chain-percentage chart, the numbers 10, 20, 40 and 80 are also in a straight line since each of the series is 100% greater than the number immediately preceding. If, however, the number 15 should fall between 10 and 20 the total distance between 10 and 20 is changed since 15 is 50% greater than 10, and 20 is 33 $\frac{1}{3}$ % greater than 15, therefore the cumula-

tive total of this chain of percentages equals the sum of 50%, plus $33\frac{1}{3}\%$, or $83\frac{1}{3}\%$, although the end figure 20, is actually 100% greater than 10. It is evident, therefore, that the intervening number 15 has reduced the true total percentage of difference between 10 and 20 from 100% to $83\frac{1}{3}\%$ —a difference of $16\frac{2}{3}\%$. On a scale such as B in Figure 1 the vertical rise from 10 to 20 would be reduced from 100 units to $83\frac{1}{3}$ units.

From Columns (1), and (4) or (5), of Table 1 it may be found that the total of the chain-percentages from 10 to 20 equals 77.47%; from 40 to 80 the total is 78.33%, and between 50 and 100, 76.14%, although in all three instances the second original number of each pair is actually 100% greater than the first. The reductions are due to the intervening numbers shown in the table. The same facts may be seen graphically by noting the different distances on scale B made by the above pairs of numbers. In Figure 1 the points defining the numbers 20 and 40 on scale B are much farther apart than the similar points on scale A. Additional comparisons will reveal similar inconsistencies which make the chain-percentage curve of doubtful value for data of this type.

Another aspect of the inconsistency of the cumulative chain-percentage chart may be illustrated by a series of numbers which includes a decrease along with an increase. If, for example the series is 10, 20, 10, the percentages of increase and decrease of the intervals are 100%, and 50%, respectively, since 20 is 100% greater than 10, and the final 10 is 50% less than 20. Hence, in per cent, the step up is twice the step down, although the two intervals are identical in absolute magnitude. The differences between the logarithms of the numbers of the series, however, are unaffected by the change from a rise to a decline; a fact that may easily be demonstrated.

Table 2 presents examples of the variations in the totals of the chain percentage when equal steps intervene between two given numbers having an actual difference of 100%. If the given numbers are 10 and 20, and 10 is increased in two equal steps to 20; that is, 10, 15, 20; the total cumulative percentage increase is $83\frac{1}{3}\%$. If 100 equal steps of .1 intervene, the total is 69.57%, or over 30% less than 100%. The total in such cases is the sum of a harmonic series having designated limits. For example, if there are four equal steps, the total equals the percentage equivalent of $\frac{1}{4} + \frac{1}{5} + \frac{1}{6} + \frac{1}{7}$. Letting n equal the number of equal steps, the total equals

$$\Sigma \left[\frac{1}{n} + \frac{1}{n+1} + \cdots + \frac{1}{n+(n-1)} \right].$$

The easiest way to determine this total is to add the reciprocals of the denominators and convert the result into percentage.

TABLE 2

No. of equal steps between the two given values, 10 and 20	Amount of each increment	Total value of the chain- percentages
1	10.0000	100.00
2	5.0000	83.33
3	3.3333+	78.33
4	2.5000	75.95
5	2.0000	74.56
6	1.6667-	73.65
7	1.4286-	73.01
8	1.2500	72.54
9	1.1111+	72.17
10	1.0000	71.88
20	.5000	70.58
100	.1000	69.57

The total of the chain-percentages of a series having an absolute range of 100% may also approach 100. If, for example, 19 falls between 10 and 20, the total is 95.26%. If 19.9 intervenes, the total is 99.05%, etc. Other illustrations can be chosen to show that the total of the chain-percentages for an actual increase of 100% can vary from 100% to something less than 70% depending upon the nature and number of intervening numbers. Although either of the above extremes would probably not occur in practice, it is evident that troublesome distortions would tend to be present, and therefore the trend of the segments of the curves would not be truly representative of the actual rates of increase as in the case of the semi-logarithmic curve.

If the differences between the logarithms, Column (6), of the original numbers (1) in Table 1 are expressed as actual numbers, as in Column (8), they correspond to the figures in Column (4) with a uniform difference of 1.0 or 100%. In other words the chain-percentage increases of the various steps are equal to the respective antilogarithms of the differences of the logarithms of the original numbers, rather than to the logarithms themselves.

The sum of the differences in Column (7) is 1.0000, which is also the difference between the logarithms of 10 and 100; the

extremes of the original numbers. The sum of the chain-percentages, however, is 278.61%, which bears no clear-cut relationship to the original figures because of the fluctuations noted above. The numbers when manipulated through the medium of logarithms retain both their absolute and relative relationships no matter what combinations are used. The same cannot be said of chain-percentages, which individually, or in cumulated totals, fluctuate considerably depending upon the nature of the original series. For accurate graphical representation of rates of change the semi-logarithmic curve is, therefore, superior.

The semi-logarithmic and cumulative chain-percentage methods may be applied to almost any historical series of statistical data; that is to quantitative measures of growth over a period of time. However, actual examples of their use in educational literature are almost, if not quite, non-existent. Educators nearly always use the arithmetic type of graph to show growth and trend with the result that interpretations are often erroneous or misleading.³

³ Allen, C. B., "Rate of Change vs. Absolute Change in School Enrollments." *Educational Administration and Supervision*. 20: 431-37 (September, 1934).

SOME EASY PROJECTS IN CHEMISTRY

Project I. Copper Etching

BY W. D. THOMPSON

Student, Senior High School, Orlando, Fla.

EDITOR'S NOTE.—The following is the first of a series of Pupil Projects prepared at our request by Charles H. Stone, B.S. of Brookline, Mass. and Orlando, Florida, with the assistance of high school chemistry students in Orlando. It is hoped that these projects may be of use to teachers who have needed such material for the more active and energetic members of their classes who have finished the regular work in advance of the others or for the use of Chemistry Club members either for their own interest or for demonstration to the club. The experiments have all been tried out by pupils in order to be sure that they are safe to perform.—FRANK B. WADE.

1. History. The etching of copper has been practiced for a good many years. Some very fine work along this line has been done by professional artists. The beginner can hardly expect to rival the work of the expert but some very satisfactory pictures can be etched by even an amateur.

2. Selection of copper sheet. Procure a sheet of copper large enough to take the picture you want to reproduce. The sheet

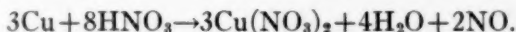
must be perfectly flat, free from dents, and other blemishes. The sheet should not be too thin, for the nitric acid used will soon eat through a sheet of very thin material; the sheet selected should be at least .2 centimeter thick.

3. Preparation of the copper surface. Scour the surface of the copper with fine sandpaper; you may remove discolored spots due to copper oxide with dilute sulphuric acid or dilute hydrochloric acid which will dissolve the oxide but will have almost no effect on the copper itself. Wash off the acid and dry the sheet.

Now melt some paraffin in a dish just hot enough so that it is quite liquid but not hot enough so that it smokes. Dip a wad of cotton batting in the melted paraffin and rub over the entire surface of the polished copper sheet; if the sheet is warmed slightly on the under side it will enable the wax to be spread more evenly. When the wax has been spread evenly over the entire surface of the sheet, let the sheet cool.

4. Indenting the picture. Select a picture made up of lines only; photographs and half tone pictures have too delicate shadings for the amateur to handle. Lay the picture upon the copper waxed surface fastening it in position so that it cannot be moved. With a pointed instrument, not sharp, trace the lines of the drawing, bearing on hard enough to make an impression that will be visible in the wax when the drawing is removed. When completely traced, remove the drawing. Retrace the lines shown in the wax with a sharp pointed instrument, cutting down to the surface of the copper sheet. Blow away any loosened wax.

5. Application of acid. Since neither sulphuric nor hydrochloric acid has any noticeable action on copper it is necessary to use nitric acid. This may be made of proper concentration by adding 5 ml of the concentrated nitric to 5 ml of water. *Caution! The concentrated acid burns skin or clothing badly.* Wrap a strip of cotton cloth around the end of a wood stick, tying it in place with some thread or string. Pour the acid into a small dish, dip the swab into the liquid, and rub over the entire surface of the waxed plate. Wherever the wax has been removed, the acid will act on the copper according to the equation:



Let the acid remain on for about five to ten minutes, according to how deeply you wish the lines of the drawing to be etched.

Finally wash off the acid, warm the sheet of copper until the paraffin can easily be wiped off with a cloth. Traces of the wax may be removed with carbon disulphide.

6. Finishing. The surface of the etching may be brightened with very fine sandpaper, or with dilute hydrochloric acid. Wipe off the surface of the cleaned copper with a cloth. To protect the copper from slow oxidation by contact with air, a very thin coat of shellac may be spread over the etched surface, the entire surface being covered.

7. Mounting. The finished etching may be mounted in a frame like a picture, or it may be set in a slot cut lengthwise in a strip of wood. The slot should be cut at a slight angle so that the copper sheet tips slightly backward. The sheet may be fastened in position by filling the slot with strong glue or other adhesive.

8. Conclusion. While the etching of copper is rather an unusual experiment for the beginner in chemistry, the pleasure of doing a really nice piece of work and obtaining a pleasing picture as a result is well worth the time and effort expended. Incidentally, quite a bit of chemistry is tied up with the experiment.

HELPING THE STUDENT TO FOLLOW HIS OWN PROGRESS

BY PAUL E. CLARK .

Muskingum College, New Concord, Ohio

During the last few years the writer has been making use of a teaching device in his college algebra classes which may be of interest to other teachers. Its value depends upon the assumption that the ability of students to evaluate their own achievements and to follow intelligently their own progress in school is an important objective of education.

At Muskingum, test grades are usually issued as per cents, but check-up grades, which are issued twice a semester, are reported by letter as A, B, C, D, E, or F. The letter C represents the average passing grade. It is not always obvious, however, from a study of test grades in per cents just what letter grade the student is earning. The use of the device explained below makes it clearer to the student just where he stands with respect to the average of the class.

The student is asked to paste a sheet of graph paper or a piece

of other suitably ruled paper in the inside of the back cover of his problem book. Per cent grades from 0 to 100 are used as ordinates and the dates of the tests are taken as abscissas. Usually five or six major tests are given during a semester including the final examination. Of course these tests have considerable influence upon the letter grade which the student receives on the check-up. As soon as a set of test papers are given back, each student is asked to plot his own grade against the date of the test. The points located up to that time are then

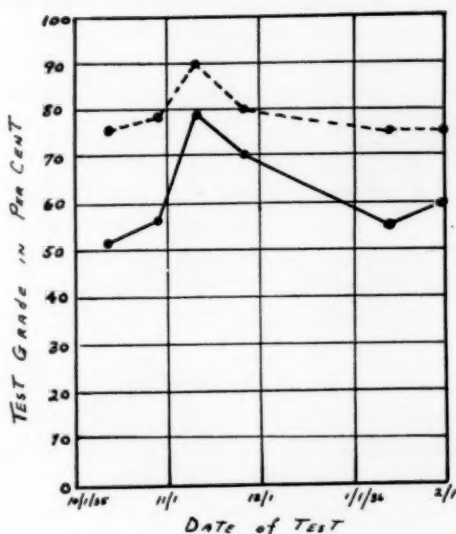


FIG. 1—TEST GRADES IN PER CENTS
PLOTED AGAINST DATES.
—— MEANS
---- STUDENT "R"

FIG. 1.

connected by means of straight lines. The mean grades are also given to the class for each test and the student is asked to plot these grades against the dates and to connect the points so found by another series of straight lines. A red or blue line can be used for one and a black line for the other, or solid and broken lines of the same color can be used to distinguish them. The student can then follow graphically his ratings and progress throughout the semester in comparison with the average for the entire class. Of course daily quiz grades or recitation grades could also be included in this scheme if it is so desired. A set of

typical graphs is shown in the accompanying figure where only the major tests are considered. In this figure the solid line represents the graph of the mean test grades and the broken line represents the corresponding graph for an actual individual student in the class. By comparing the graphs, the student is given vivid information concerning his own standing, and, in the case of a mathematics class, the student also obtains important practice in the preparation and interpretation of graphs.

In the last two years the writer has received seventy student estimates of their own college algebra check-up grades. These estimates were made after the teacher had reported his grades to the office of the Dean of the College but before the students had received them. Of these, fifty-four, or seventy-seven per cent, have been exactly what the teacher had estimated for them and not a single student estimate differed from the teacher's by more than one grade letter. Of course it is impossible to say what the use of plotting individual and mean test grades had to do with this good agreement, but the writer is so well pleased with the operation of this device that he intends to extend its use to all of his classes including several chemistry courses.

Since learning of this practice, several other teachers at Muskingum have asked for the details of its operation and they, too, have signified their intentions of using it in their classes. In view of this fact, the writer thought that perhaps other teachers, both in high-school and in college, would like to be reminded of it.

A WATER FILTRATION PLANT MODEL

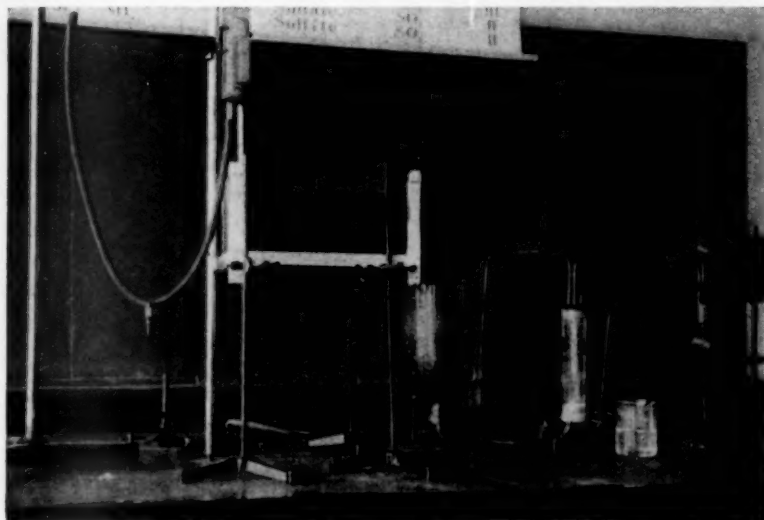
BY THOMAS R. BALDWIN

Senior High School, High Point, N. C.

This is a description of apparatus designed to show the essential steps in water purification as practiced by the average filter plant. It is in no sense designed to produce water sufficiently pure for drinking purposes, but it does give a comprehensive idea of the entire process which students often fail to grasp by visiting a large plant.

The raw water source is represented by the large funnel A, which is fastened to some convenient support. The funnel is connected to a piece of rubber tubing, the other end of which

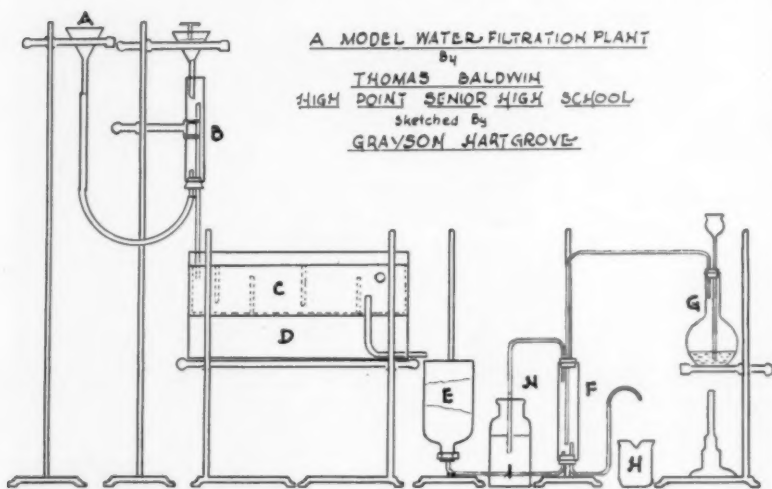
is connected to a short piece of glass tubing which in turn is inserted in a two-holed rubber stopper. This stopper fits in the lower end of a $1\frac{1}{2}$ inch glass tube about 8 inches long. A chimney from an apparatus for demonstrating convection currents was used here. Extending through the other hole of the stopper, almost to the top of the glass tube, and for some distance below, is another piece of glass tubing. A small funnel containing alum, and with some means of controlling its flow, is suspended above the large tube. This entire assembly, B, represents the machine for introducing the precipitating agent into the water.



The mixture of precipitating agent and water then flows from B into C by gravity, in fact it will be noticed that water flows through the entire apparatus in this way. C is an oblong wooden box of the "Kraft" cheese variety, supported in a pneumatic trough, D. Between the sides of the box are fixed baffles, so arranged as to give the water an undulating movement as it passes over and under them. The water drains from the sides of this box into the container D, which represents the sedimentation basin. Here the gelatinous precipitate formed from the alum slowly settles, carrying much suspended matter with it. A glass L, extending almost up to the drain in the side of the baffle box, is fixed in the side of the sedimentation basin. As soon as water reaches the level of the opening of this tube, it will begin to drain into the sand filter, E.

The filter is made from a bell jar or jug with the bottom cut out. It contains a layer of sand supported by a layer of gravel. In the mouth of the jug is inserted a rubber stopper containing a glass L. This L is connected by a piece of rubber tubing to the chlorinator, F.

The chlorinator is made from a piece of large glass tubing similar to that in the apparatus used for introducing alum. A two-holed rubber stopper is inserted in each end of this tube. In the bottom stopper is inserted a glass L leading from the sand filter and a glass S as shown in the sketch, to act as a drain for the system. Through the top are inserted two glass



L's, one extending almost to the bottom of the apparatus. This long L is connected to the chlorine generator G, and the short L is connected to a bottle N for neutralizing excess chlorine. This bottle contains a solution of sodium hydroxide which prevents the escape of chlorine gas into the room.

To start the apparatus, pour muddy water into the funnel A, and introduce the precipitating agent at B from time to time. By gravity C will gradually fill and water will flow into D, and then into E. As soon as F is filled with water, start the chlorine generator by heating a mixture of sodium chloride, manganese dioxide, and sulfuric acid. Bubbles of chlorine will be seen to rise in F, and the excess will escape and be neutralized in N. The "pure" water, much clearer than when introduced at A, but strong in chlorine, will collect in H.

SCIENCE CERTIFICATION FOR HIGH SCHOOL TEACHING

BY WILLIAM ALBERT EARL WRIGHT

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The various states have made commendable progress in increasing requirements for teaching certificates during the past twenty years. However, there are still certain sections which are urgently in need of revision.

The most vulnerable, and the most widely criticized section of the certification laws and requirements of the various states, is that section which deals with blanket certification in science. A blanket science certificate may be defined as a certificate which enables a teacher to teach any of the sciences offered in the various curricula of the high schools.

Blanket certification, in itself, may not be objectionable, but the small number of semester hours required by the various states is decidedly objectionable to the many individuals vitally interested in the problem of increasing requirements for science certification.

In 18 states, specifically mentioning science in their certification bulletins or through correspondence, the number of semester hours required for blanket certification ranges from 12 to 36.

This study reveals that 33.3 per cent of the 18 states grant blanket certificates on a major amounting to less than 20 semester hours of science credit; 38.9 per cent grant certificates on between 20 and 29 semester hours of science credit; and 27.8 per cent require 30 or more semester hours. Thirteen states, or 72.2 per cent, require 24 semester hours or less.

Certain states permit blanket science certification on a minor amounting to considerably less than the figures mentioned in the previous paragraph.

In addition, certain states have minimum requirements of only from three to six semester hours in the specific science field in which the teacher is employed.

Equally as objectionable is the practice of granting certificates to teach the physical sciences, both physics and chemistry, upon the submission of 12, 15, or 16 semester hours of work in chemistry and physics. In certain instances, there are minimum requirements of six semester hours each in chemistry and physics.

As in the case of blanket science certification, the practice of granting certificates in the physical sciences may not be criticized provided that a sufficient number of semester hours be required for certification.

Several years ago the writer conducted a survey (unpublished) covering 175 high school science teachers, teachers college science teachers, liberal arts college science teachers, superintendents of schools, and members of state departments of education. The median number of semester hours recommended by the group surveyed as a minimum requirement for a science certificate, covering chemistry, physics, and biology, was 12 semester hours in each of two science fields and 15 in the third.

Therefore, it may readily be seen that in actual practice the certification of science teachers is far behind the recommendations of the individuals covered in the unpublished survey.

THE USE OF LIQUID CARBON DIOXIDE IN THE LABORATORY AS A REFRIGERANT

BY D. C. BARRUS

*Science Department, Genesee Wesleyan
Seminary, Lima, New York*

Practically all laboratories are equipped with burners and other heating devices but few are furnished with refrigerating units or equipment. This has generally resulted that the large majority of demonstrations at other than room temperatures have been in conditions above average of 20° to 30°C. However, a large number of experiments at low temperatures are both attractive and instructive.

In our laboratory we produce our low temperatures with a solution of solid carbon dioxide in ether. We prepare our solid carbon dioxide from liquid CO₂. At all times the steel cylinder containing the liquified gas is kept in a slanting position so that liquid may be run out of the cylinder slowly by a turning of the valve into a cloth bag of sufficient thickness to facilitate the solidification of the CO₂ into the characteristic "white snow." By mixing this with sufficient ether in a beaker or calorimeter a temperature of around -70°C. is obtained. If the beaker or calorimeter is well insulated the low temperature may be maintained longer and more efficiently. After the experiments are

over the ether may be saved and used over again with but little waste.

SOME EXPERIMENTS

Sheet rubber placed in this temperature will become very brittle and can be broken much as thin celluloid may be. Mercury may be solidified in the form of a hammer with a wooden handle and can be used to drive a nail. Gases like ammonia, sulfur dioxide and chlorine are easily liquefied. Numerous liquids as carbon tetrachloride, benzene, bromine and the whole list of solutions are easily solidified. If one wishes to test the freezing point of these it is conveniently ascertained by observing the temperature when these are nearly melted.

Among the instructive demonstrations we have performed in our laboratory are those for determining the freezing point depression due to the presence of solutes in a solution. We tested out the freezing points of two different 300% molal solutions. By dissolving 9.6 grams of methyl alcohol in 100 cc. of water and 27.6 grams of glycerol alcohol in 100 cc. of water we had our 300% molal concentrations. Freezing these with the CO₂ snow and ether, we observed their melting points at -5.5°C . (our thermometer was not sufficiently sensitive to make closer measurement). By dividing this temperature by 3 a result of -1.85°C . is obtained for a 100% molal solution. This agrees fairly well with the accepted value of -1.86°C .

Aside from being a convenient method for producing low temperatures it is very economical. Carbon dioxide liquid is sold in steel tanks containing about 50 pounds of the substance. Perhaps one cylinder which costs between four and five dollars from commercial companies will last for a year. The length of time, of course, depends upon the extent to which it is used. Its convenience, always available within five minutes, and its cheapness has made the steel cylinder of liquid carbon dioxide one of the articles of permanent equipment in the laboratory of Genesee Wesleyan.

SYNTHETIC EMERALDS MORE EXPENSIVE THAN NATURAL STONES

Buyers of emeralds need have no fear of getting synthetic stones instead of natural gems, says Dr. W. F. Foshag, mineralogist at the National Museum, for it costs much more to make emeralds in the laboratory than it does to dig them from the mine. Synthetic emeralds also differ from natural stones in so many ways that any competent jeweler can easily tell the natural from the manufactured gem.

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON
State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution as on the following pages.

The Editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

NOTE. Persons sending in solutions and submitting problems for solution should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solutions.

2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

3. In general when several solutions are correct, the one submitted in the best form will be used.

LATE SOLUTIONS

1526. *Max Lipshitz, Bayonne, N. J., Daniel Finkel, N. Y. C., Ethel Cain, Perry, Ia.*

1530. *C. W. Trigg, Los Angeles.*

1524. *Daniel Finkel.*

1528. *D. L. MacKay, New York, A. MacNeish, Chicago.*

1532. *Proposed by W. R. Smith, Lewis Institute, Chicago.*

What is the longest rectangle one foot wide which can be cut from a circular sector which is the surface of a cone whose slant height is 10 ft. and altitude 3 ft.?

Solution by A. MacNeish, Chicago.

Let x = the angle of the sector

y = the radius of the base of the cone, and

L = the length of the required rectangle.

$$y = \sqrt{10^2 - 3^2} = \sqrt{91}$$

Therefore the circumference of the base of the cone and the arc of the sector is $2\pi\sqrt{91}$

and
$$x = \frac{2\pi\sqrt{91}}{10} \text{ radians} = \frac{2\pi\sqrt{91}}{10} \cdot \frac{180}{\pi} \text{ degrees}$$

$x = 36\sqrt{91}$ degrees which is greater than a semicircle.

Therefore the base of the required rectangle lies along the diameter of the circle of which the sector is a part.

1534. *Proposed by Mary R. Jones, Tulsa, Okla.*

Find the area of the loop of the folium $x^3 + y^3 = 3xy$.

First Solution by Raymond R. Schnepp, San Antonio, Texas.

In general, the area, A , of any closed plane region is the line integral

$$\frac{1}{2} \int_0 (xdy - ydx)$$

taken around the boundary in a positive sense.

To apply this to the folium, let $y = tx$. Then

$$x = \frac{3t}{1+t^3}$$

and

$$xdy - ydx = x^2 d(y/x) = \frac{9t^2 dt}{(1+t^3)^2}.$$

Along the loop, t varies from 0 to ∞ .

$$\therefore A = \frac{1}{2} \int_0^{\infty} \frac{9t^2 dt}{(1+t^3)^2} = \frac{3}{2},$$

the integral being a simple power form.

Second solution by Arthur Dansl, Collegeville, Minn.

Transforming into polar coordinates, the equation reduces to

$$\rho = \frac{3 \cos \theta \sin \theta}{\sin \theta + \cos \theta}$$

$$\therefore A = \frac{1}{2} \int_0^{\pi/2} \rho^2 d\theta = \frac{9}{2} \int_0^{\pi/2} \frac{\sin^2 \theta \cos^2 \theta}{\sin^3 \theta + \cos^3 \theta} d\theta.$$

To integrate let $u = \tan \theta$, and then

$$A = \frac{9}{8} \int_0^{\infty} \frac{u^2 du}{(1+u^3)^2} = \frac{3}{2} \text{ by easy integration.}$$

Third Solution by Walter R. Warne, New York.

By polar coordinates

$$\rho = 3 \frac{\tan \theta \sec \theta}{1 + \tan^3 \theta}$$

$$\therefore \frac{A}{2} = \frac{1}{2} \int_0^{\pi/4} \rho^2 d\theta = \frac{9}{2} \int_0^{\pi/4} \frac{3 \tan^2 \theta d \tan \theta}{(1 + \tan^3 \theta)^2} = -\frac{3}{2} \left(\frac{1}{1 + \tan^3 \theta} \right) \Big|_0^{\pi/4} = \frac{3}{4}.$$

Hence, $A = 3/2$. Note: In determining the limits observe that the curve is symmetrical with respect to the line $y = x$. Hence the angle limits are 0 and $\pi/4$ for the lower half of the loop.

Fourth Solution by Eric Tuer, Toronto, Canada.

Let $y = tx$, then

$$x = \frac{3t}{1+t^3}, \quad y = \frac{3t}{1+t^3}$$

Hence

$$A = \int ydx = 3 \int_0^{\infty} \frac{(1-2t^3)(3t^2)dt}{(1+t^3)^3},$$

which by easy integration yields $3/2$ for the area.

Fifth Solution by Charles W. Trigg.

By rotating the axes through 45° , the equations reduce to

$$y = \pm \sqrt{\frac{3\sqrt{2}-2x}{3(2x+\sqrt{2})}}.$$

And the asymptote reduces to $x = -\frac{\sqrt{2}}{2}$ with intercepts (0, 0) and

$\left(\frac{3\sqrt{2}}{2}, 0\right)$. The area of the loop between the limits 0 and $\frac{3\sqrt{2}}{2}$ is $3/2$.

It will be observed that the area of the loop of the folium of Descartes is equal to the product of the two segments into which the curve and the asymptote divide the perpendicular through the node to the asymptote.

1535. *Proposed by Nathan Altshiller-Court, University of Oklahoma.*

Through a given point to draw a line passing through the inaccessible center of a given sphere.

Solution by Charles W. Trigg, Eagle Rock H.S., Los Angeles.

It is assumed that in space it is possible to construct a circle, to draw a line through two points and to pass a plane through three points.

If the given point is without the sphere and the interior of the sphere is inaccessible, or if the point is within the sphere and the center is inaccessible proceed as follows: With an appropriate radius and the given point, P , as center describe a circle on the surface of the sphere. (The radius of this circle will of course be less than the radius employed.) Connect P to three arbitrary points, A , B , and C , on the circle. With a shorter radius and P as center, strike off PM , PN , and PQ on PA , PB , and PC , respectively. Pass a plane through M , N , and Q and in this plane draw a circle through M , N , and Q . Thus the center, R , of this circle will be found. PR is the required line.

If P is on the surface of the sphere construct a plane through P tangent to the sphere and erect a perpendicular to this plane at P . Or, if some of the interior of the sphere near P is accessible, proceed as before by describing a circle on the sphere, pass a plane through three points of this circle, and determine its center R . Again PR is the required line.

Solutions were also offered by the proposer. References to this problem may be had in the proposer's *Modern Pure Solid Geometry*.

1536. *Proposed by Walter R. Warne, New York University.*

Solve the system for x , y , z .

$$x^2 + y + z = 21$$

$$x^2 + yz = 22$$

$$x^2 yz = 96.$$

Solution by Julius H. Hlavaty, New York.

Let $x^2 = a$, $y + z = b$, $yz = c$.

Then we have:

$$a + b = 21 \quad (1), \quad a + c = 22 \quad (2), \quad ac = 96 \quad (3)$$

Solving equations (2) and (3) for a and c and then finding b :

$$a = x^2 = 16 \quad (4) \quad \text{and} \quad x^2 = 6 \quad (7)$$

$$b = y + z = 5 \quad (5) \quad y + z = 15 \quad (8)$$

$$c = yz = 6 \quad (6)$$

$$yz = 16 \quad (9)$$

Solving equations (5) and (6) and combining the solutions with $x = \pm 4$,

$$x = 4, \quad 4, \quad -4, \quad -4$$

$$y = 3, \quad 2, \quad 3, \quad 2$$

$$z = 2, \quad 3, \quad 2, \quad 3$$

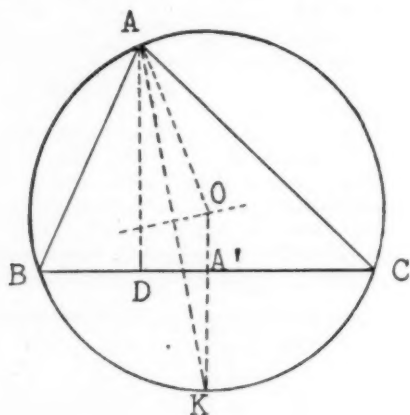
Solving equations (8) and (9) and combining the solutions with $x = \pm \sqrt{6}$

$$\begin{array}{cccc} x = & +\sqrt{6}, & +\sqrt{6}, & -\sqrt{6}, & -\sqrt{6} \\ y = & \frac{15+\sqrt{161}}{2}, & \frac{15-\sqrt{161}}{2}, & \frac{15+\sqrt{161}}{2}, & \frac{15-\sqrt{161}}{2} \\ z = & \frac{15-\sqrt{161}}{2}, & \frac{15+\sqrt{161}}{2}, & \frac{15-\sqrt{161}}{2}, & \frac{15+\sqrt{161}}{2} \end{array}$$

Solutions were also offered by Margaret Joseph, Milwaukee, Wis., Monroe Hall, Onarga, Ill., Kenneth P. Carlson, Brule, Neb., H. R. Mutch, Charles W. Trigg, Los Angeles, A. MacNeish, Chicago, P. Boukisis, Evanston, Ill., Walter H. Carnahan, Indianapolis, David Rappaport, Chicago, Eric Tuer, Toronto, Canada, J. Byers King, Corsica, Pa., Raymond F. Schnepf, San Antonio, Texas, and the proposer.

1537. Proposed by William W. Taylor.

Construct a triangle, given the difference of the base angles, the difference of the projections of the two sides upon the base, and the difference of the exradius relative to the base and the inradius.



Construction: Draw the line $A'D$ equal to one-half the given difference of the projections and at A' draw the perpendicular $A'K$ equal to one-half the given difference of the two radii. At K construct the angle $A'KA$ equal to one-half the given difference of the base angles and meeting the perpendicular to $A'D$ at D in the point A . Erect the perpendicular bisector of AK and meeting KA' produced in the point O . Then with O as a center and radius OK describe a circle meeting $A'D$ produced in points B and C . Draw AB and BC . Triangle ABC is the required triangle.

Proof: The following statements may be verified in *College Geometry*—Altschiller-Court.

$$\angle A'KA = \frac{1}{2} \angle DAO = \frac{1}{2}(B-C)$$

$$A'K = \frac{1}{2}(r'-r)$$

$$A'D = \frac{1}{2}(p-q).$$

Solutions were also offered by Charles W. Trigg, Los Angeles, and H. R. Mutch.

HIGH SCHOOL HONOR ROLL

The Editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

For this issue the Honor Roll appears below:

1526. *Ethel Schwig and Phyllis Nolte, Dundee (Ill.) Community H.S., Alfred Root, Perry, Ia.*

1532, 6. *Peggy Lovell, Withrow H.S., Cincinnati, Ohio.*

1536. *Joseph Aldrich, Whitefish Bay (Wis.) H.S., Richard Slayback, Connersville, Ind., R. H. Schmied, University of Texas, Maurits dr Regt, Simon Gratz H.S., Philadelphia.*

PROBLEMS FOR SOLUTION

1550. Find a formula for the number which is divisible by 7, such that when the number is divided by each of the integers, 2, 3, 4, 5, 6, a remainder of one results.

1551. *Proposed by Raymond Beck, Wilmington, California.*

How many different triangles are there whose sides are integers less than 100?

1552. *Proposed by Willis Waggoner, Syracuse, N. Y.*

Eliminate θ from the equations:

$$a \cos \theta - b \sin \theta = c$$

$$2ab \cos 2\theta + (a^2 - b^2) \sin 2\theta = 2c^2$$

1553. *Proposed by Dewey C. Duncan, Compton, Calif.*

Determine common factors of the integers x , y , and z which satisfy $3x^2 + 4y^2 = 5z^2$ and solve this equation completely. (From Dresden's *An Invitation to Mathematics*, page 11.)

1554. Problem 1533 offered by Walter R. Warne was incorrectly given through an error in editor's office. As a much more interesting problem it is now correctly offered.

Eliminate θ and ϕ from the system of equations:

$$a \cos^2 \theta + b \sin^2 \theta = c$$

$$b \cos^2 \phi + a \sin^2 \phi = d$$

$$a \tan \theta = b \tan \phi.$$

1555. *Proposed by Walter R. Warne.*

In the folium of Descartes (see 1534) can the area of the loop be found by any branch of mathematics other than the integral calculus?

Also find or discuss the area formed by the asymptote of the folium and the portion of the folium exclusive of the loop.

SCIENCE QUESTIONS

April, 1938

Conducted by Franklin T. Jones

(Send all communications to Franklin T. Jones, 10109 Wilbur Avenue, S. E. Cleveland, Ohio.)

Readers are invited to co-operate by proposing questions for discussion or problems for solution.

Examination papers, tests, and interesting scientific happenings are very much desired. Please enclose material in an envelope and mail to Franklin T. Jones, 10109 Wilbur Ave., Cleveland, Ohio. Thanks!

Your classes and yourself are invited to join the GQRA (Guild Question Raisers and Answerers). More than 220 others have already been admitted to membership by answering a question or proposing one that is published.

BECOME MEMBERS OF THE GQRA

HOW COWS SLEEP

833. *Proposed by Margaret Bobb, Mercy "Bio-ite Club," Mercy High School, Milwaukee, Wisconsin. (Elected to the GQRA, No. 226).*

"While I was visiting in the country, I noticed that, regardless of what time of the night I saw them, the cows were always awake. Even though I did not know much about Biology at that time, it seemed strange to me that I never saw the cows sleep. Of course, I started to ask questions, but, because it seemed to be a foolish question that did not enter into the minds of many people, I did not receive a satisfactory answer. Now I am asking your help, Mr Jones,—Can you, through your magazine and its readers give me an answer to this problem?"

DO COWS SLEEP, IF SO, WHEN AND HOW?

"The Bio-ites of Mercy have answered many questions which have appeared in the SCHOOL SCIENCE & MATHEMATICS magazine, but this is the first time a Bio-ite has sent a question in. I hope I shall be as successful in getting an answer as the other Bio-ites have been in giving them."

"LOOK"

834. *Proposed by C. S. Greenwood, GQRA No. 135, Teacher of Science, Sheffield, Pa.*

"On page 7 of the issue of *Look*—the picture magazine—for Feb. 1, 1938, there is a series of four photographs showing a bullet passing through a forty-watt bulb after having been fired from a gun.

"The glass breaks *outward* at both the place of entrance and the place of exit of the bullet.

"If the pressure is very low, why would the glass not break *inward*, at least at the point of entrance?"

THE WEIGHT OF IRON AND MAGNETISM

835. *Proposed by Aaron Goff (Elected to the GQRA, No. 227), Cleveland Junior High School, Newark, N. J.*

"Having for some time been an interested reader of your question de-

partment of SCHOOL SCIENCE AND MATHEMATICS, I am now stirring myself to become a member of the GQRA.

"We have, for a long time, recognized the fact that the earth acts as a huge magnet, explaining thereby the action of the magnetic compass and its deflections. It has occurred to me that too much stress has been placed upon the polar properties of this magnet. I have yet to see any treatment of its attractive effects on iron, cobalt, nickel, or their alloys.

"In other words, what percentage, if any, of the weight of iron is due to the magnetic attraction of the earth?"

ELECTRIC CHARGES

836. *Proposed by Leo R. Spogen, GQRA, No. 64, Red Lodge, Montana.*

"Once, in the past, I rubbed a glass tube with silk and produced an electric charge as in the usual case. Upon continued rubbing the glass rod would not charge the electroscope. Why?"

BRAIN TEASER

837. *Lifted from THE DOUBLE BOND of the Western New York Section of the American Chemical Society, R. B. MacMullin, Puzzle Editor. (GQRA, No. 204).*

Cross Word Puzzle

Horizontal

1. Insects.
2. We see with them.
3. To annoy.
4. You should solve this puzzle with this but probably won't.

Vertical

1. Dogs do it.
2. So do snakes.
3. A large one is a mouthful.
4. Puzzles delight when their victims do it.

	1	2	3	4
1				
2				
3				
4				

ICE THAT SINKS

838. *From a Newspaper Clipping.*

How make ice that sinks?

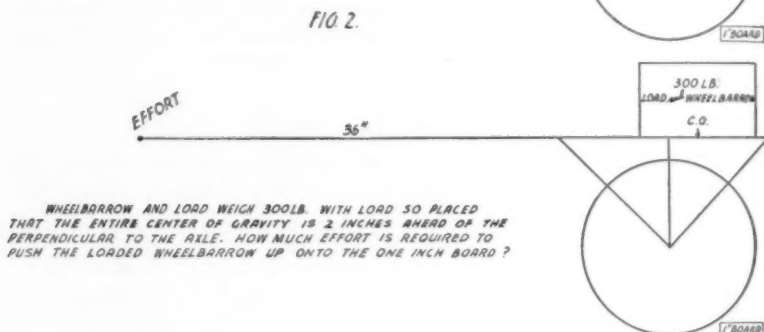
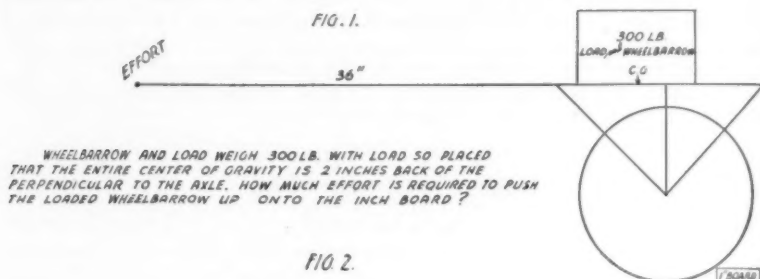
HOW LOAD THE WHEELBARROW

816. *Proposed by Le Roy Simkins (GQRA, No. 197), and Donald Fleming (GQRA, No. 198) through J. B. King (GQRA, No. 88), all of Corsica-Union High School, Corsica, Pa. (Please refer to SCHOOL SCIENCE AND MATHEMATICS, December, 1937, Science Questions Dept. for complete statement of the problem and explanatory figures.)*

All other things being equal which would require the lesser amount of effort to push up onto a 1 inch board and how much.

- (1) a wheelbarrow as in figure 1 with the load and wheelbarrow having

a total weight of 300 lb. and so arranged that the center of gravity of the entire apparatus is 2" back of the axle so that the operator lifts up on the handles and pushes, or



(2) a wheelbarrow as in figure 2 with the same total weight so placed that the center of gravity is 2" ahead of the axle and the operator must hold down on the handles and push.

Each wheelbarrow has a wheel 12" in diameter. The effort in each case is being exerted by the hands placed 36 inches back of the perpendicular to the axle and the body of the wheelbarrow is to be held so as to be in a horizontal position. Since the friction of the wheelbarrows could be assumed to be the same, it may be neglected in the problem. The wheel in each case is against the board to start with.

Solution by F. H. Wade (GQRA, No. 205), Lewis Institute, Chicago, Ill.

If there is no axle friction the reaction at the bump passes through the center of the wheel, and this fixes its direction at $\arcsin 5/6$. The wheelbarrow as a whole is acted upon by three forces: the weight, the bump, and the push at the handle. These three must intersect at a common point for equilibrium. The figure (Fig. 3) shows the case where the weight is ahead of the axle, and the required push is easily found by drawing the force triangle as indicated. (Fig. 4).

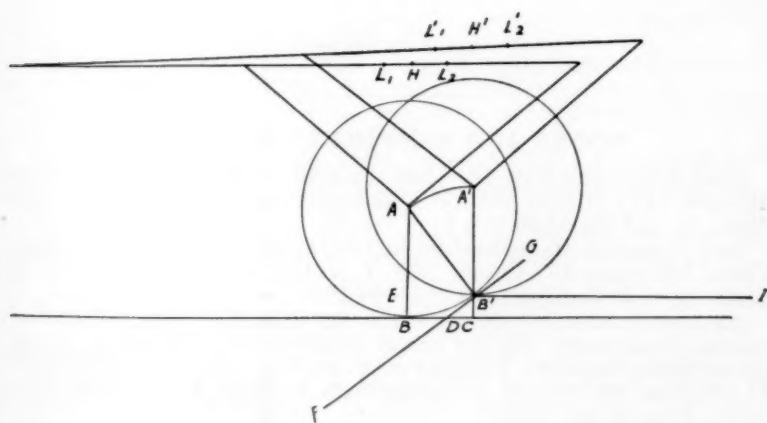
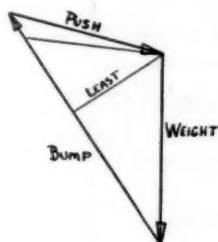
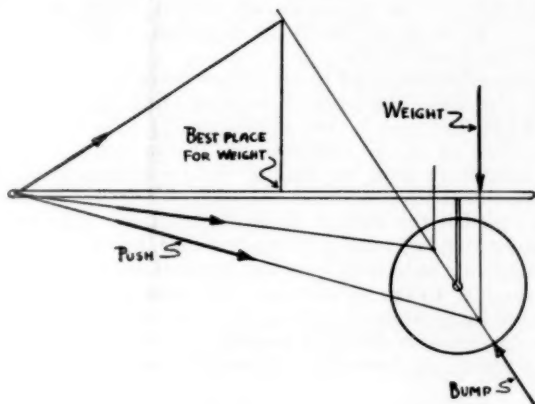
It will be seen that if the weight is behind the axle, the angle of push is less and less push will be required. Pursuing this idea farther, the angle for least push is the perpendicular let fall as shown in the triangle of forces, and then it is a matter of geometry to find where the weight should be.

The inventor knew all this when he put the barrow behind the wheel.

Solution by W. R. Smith, Lewis Institute, Chicago, Ill. (GQRA, No. 176).

The accompanying sketch (Fig. 5) is intended to show the wheelbarrow in two positions, one when the wheel has just reached the obstruction, the

other when it has reached a point where the axle is directly over the edge of the board. In passing from the first position to the second the axle moves along the curve AA' . As this curve is steepest at A and becomes horizontal at A' , the force necessary to move the barrow is greatest in the first position and diminishes to zero when it reaches the second. This direction of motion at the first position is along the line FG , tangent to the



wheel at B' , the point of contact with the board A force acting in the direction FG can be resolved into horizontal and vertical components by the right triangle $B'CD$. The dimensions of this triangle may be obtained as follows: $B'C = 1$, $\triangle B'CD$ is similar to $\triangle BEA$ $AB' = 6$, $AE = 5$. $\therefore B'E = 3.316$ $3.316:1::6:BD::5:DC$. $BD = 1.809$. $DC = 1.504$. If the CG is at L_1 (as in Fig. 1 as published) the weight on the axle is $34/36$ of 300 lbs = 283.3 lbs. To move this in the direction Fg will require a horizontal force $x = 1./1.504 \times 283.3 = 188.4$ lbs. If the cg is at L_2 , the weight on the axle will be $300 \times 38/36 = 316.7$ lbs. To move this in the direction Fg will require a force of $y = 1/1.504 \times 316.6 = 210.5$ lbs.

\therefore The initial effort required to push the barrow is greater in the second case than in the first. The work done in pushing the wheelbarrow onto the board in the first case is that of raising 283.3 lbs approximately one inch (a little less) or 283.3-inch pounds. In the second case it is raising 316.7 lbs a little more than one inch or 316.7 + inch pounds. So that the work is greater in the second case.

If the man pushes the barrow along the level $B'I$ until he reaches the board. When he steps up onto it in the first case, he raises his own weight, and lifts enough on the barrow to bring the total work done on the barrow to 300 inch pounds. In the second case, the load on barrows helps lift him on to the board by an amount just equal to the excess of the work already done on the barrow over 300 inch pounds. So that the work done by the man is the same in the two cases—raising his own weight +300 lbs one inch.

It is rather interesting to note that the work done in pushing a barrow with the load in the ordinary position over a narrow obstruction is less than that of raising the load to the height of the obstruction.

FIND THE MISTAKES

812. *From a Paper of the College Entrance Examination Board—Physics February, SCHOOL SCIENCE & MATHEMATICS, page 229.*

Something wrong pointed out by—

Leo J. Jennings (Elected to the GQRA, No. 224), Somerville High School, Somerville, Mass,

G. John Leies (Elected to the GQRA, No. 225), University of Dayton, Dayton, Ohio.

Join the GQRA!

BOOKS AND PAMPHLETS RECEIVED

Snakes Alive and How They Live, by Clifford H. Pope. Cloth. Pages xii + 238. 14.5 × 21.5 cm. 1937. The Viking Press, 18 East 48th Street, New York, N. Y. Price \$2.50.

Both Sides of the Microphone, by John S. Hayes, and Horace J. Gardner. Cloth. 180 pages, 13 × 19 cm. 1938. J. B. Lippincott Company, 227 S. Sixth Street, Philadelphia, Pa. Price \$1.25.

Elementary Experimental Chemistry, by John C. Hogg, Chairman, Science Department, Phillips Exeter Academy, and Charles L. Vickel, Instructor in Chemistry, Phillips Exeter Academy. Cloth. Pages xvi × 287. 14 × 21.5 cm. 1937. Oxford University Press, 114 Fifth Avenue, New York, N. Y. Price \$2.00.

Laboratory Directions in College Zoology, by Henry Lane Bruner, Professor of Zoology in Butler University, Indianapolis, Indiana. Revised Edition. Cloth. Pages xiv+163. 14×21.5 cm. 1938. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price \$1.75.

Computation and Trigonometry, by Harold J. Gay, Professor of Worcester Polytechnic Institute. Cloth. Pages vii+231. 14×21.5 cm. 1938. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price \$1.90.

Second-Year Algebra, by Herbert E. Hawkes, Professor of Mathematics in Columbia University; William A. Luby, Head of the Department of Mathematics in the University of Kansas City; and Frank C. Touton. Advanced Edition. Cloth. Pages viii+504+x. Pages 12.5×19 cm. 1938. Ginn and Company, 15 Ashburton Place, Boston, Mass. Price \$1.48.

Chemistry (with some Geology), by J. A. Lauwerys, Lecturer and Tutor in Methods of Science, Institute of Education, London, and J. Ellison, Senior Science Master, Trinity County School, N.22. Cloth. Pages xii+356. 12×18.5 cm. 1938. University of London Press, Ltd., 10 & 11 Warwick Lane, London, E.C.4. Price 4s. 6d.

Sound Waves and Acoustics, by M. Y. Colby, Professor of Physics, The University of Texas. Cloth. Pages xi+356. 14×21.5 cm. 1938. Henry Holt and Company, 257 Fourth Avenue, New York, N. Y. Price \$2.80.

Differential Calculus, by S. Mitra, Professor at Trinity College, Cambridge and G. K. Dutt, Professor at Sidney Sussex College, Cambridge. Cloth. Pages xiv+302. 12.5×19.5 cm. 1937. Chemical Publishing Company, 148 Lafayette Street, New York, N. Y. Price \$4.00.

High School Biology, by Ralph C. Benedict, Professor of Biology in Brooklyn College; Warren W. Knox, Acting Director, Division of Inspection and Examinations in the New York State Department of Education; and George K. Stone, Instructor in Biology, Junior-Senior High School, Hicksville, Long Island. Cloth. Pages xi+724. 13.5×21.5 cm. 1938. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price \$2.00.

Guide to High School Biology, by Edna Craig, Instructor in Biology, Newburgh Free Academy, Newburgh, New York, and George K. Stone, Instructor in Biology, Junior-Senior High School, Hicksville, Long Island. Paper. 146 pages plus one Test for each Unit and two Final Tests. 21×28 cm. 1938. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price 96 cents.

Why Aeroplanes Fly, by Arthur Elton, and Robert Fairthorne. Paper. Pages xi+82. 15×20 cm. 1937. Longmans, Green and Company, 114 Fifth Avenue, New York, N. Y. Price 56 cents.

Part-Time Farming in the United States, prepared under the Supervision of Z. R. Pettet, Chief Statistician for Agriculture. Paper. 205 pages. 22.5×29 cm. 1937. For sale by the Superintendent of Documents, Washington, D. C. Price 50 cents.

Technical Details of a Battery. Paper. 8 pages. 22×27 cm. Available upon request to all High School and University Instructors. Thomas A. Edison, Inc., Kearny, New Jersey.

Death Begins at 40. Paper. 36 pages. 15×22.5 cm. The Travelers Insurance Company, Hartford, Connecticut. Available upon request.

BOOK REVIEWS

Algebra for Today, First Year, by William Betz, Vice-Principal of the East High School and Specialist in Mathematics for the Public Schools of Rochester, New York. Pages xii plus 565. 15×21.4×3 cm. 1937. Ginn and Company, Boston.

The course is built around six central objectives: the language and ideas of algebra; the formula; the equation; the graph; fundamental principles and processes; and problem solving. The common bond connecting these objectives is the study of relationships. Every chapter contributes to this underlying theme.

The organization of the book permits at least three major adaptations, with optional work and supplementary honor work increasing further the flexibility. Problem solving is made a definite part of the course and an abundance of well chosen problem material is supplied.

A complete reviewing and testing program provides an inventory test in arithmetic, sixteen chapter tests, many sets of practice and review exercises, a general summary, comprehensive review lessons, and a comprehensive mastery test.

The format consists of large open pages, clear and readable type, and many illustrations.

The course meets the college entrance requirements adequately.

JOSEPH J. URBANCEK

The National Council of Teachers of Mathematics, The Twelfth Yearbook' Approximate Computation, by Aaron Bakst, Ph.D. Cloth. Pages xvi + 287. 14.5 × 23 cm. 1937. Bureau of Publications, Teachers College, Columbia University, New York, N. Y. Price \$1.75.

The teacher of secondary school mathematics is constantly dealing with the nature of approximate numbers, and with computations involving such numbers. A clear understanding of the elementary ideas concerning approximations and approximate numbers will tend to eliminate much of the apparent confusion concerning the degree of accuracy or of acceptance of the results of computation. In this volume Dr. Bakst has accumulated a vast amount of useful material concerning approximate numbers, material which is elementary enough to be used with profit by the pupil in any high school mathematics class, and material which is complete enough to give the teacher of mathematics an adequate background to handle the subject with understanding.

The National Council of Teachers of Mathematics is to be congratulated for making this excellent study of Dr. Bakst available to the teachers and students of mathematics. Every teacher of mathematics both in the elementary school and in the high school should have a copy of the Twelfth Yearbook.

J. S. GEORGES

Sound Waves and Acoustics, by M. Y. Colby, Professor of Physics, The University of Texas. Cloth. Pages xi + 356. 14 × 21.5 cm. 1938. Henry Holt and Company, 257 Fourth Avenue, New York, N. Y. Price \$2.80.

This text provides the basic material for a course in sound to follow the year of general college physics. The first chapter, covering forty pages, reviews the subject matter of sound usually given in the general course. The body of the text, 270 pages in length, is divided into the following chapters:

- II. Vibratory Motion
- III. Transverse Waves
- IV. Longitudinal Waves
- V. Longitudinal Vibrations of Bars
- VI. Velocity of Sound. Vibrating Air Columns. Doppler Effect
- VII. Interference, Beats, and Combination Tones

- VIII. Intensity of Sound. Derivation of Physical Relations
- IX. Intensity of Sound. Measurement by Resonance Methods
- X. Intensity of Sound. Measurement by Non-resonant Microphones
- XI. Hearing
- XII. Architectural Acoustics

The plan of presentation is to give (1) a mental picture of the phenomena under consideration, (2) the mathematical analysis, (3) the applications, methods of measurement, description of instruments used, and results obtained, (4) a set of problems covering the theory. The arrangement is ideal for students with limited experiences in science.

The text is reliable, contains sufficient material for a short course, covers the classical analyses and experiments thoroughly, and includes sufficient discussion of the more recent investigations to acquaint the student with the rapid developments now taking place in the science of sound. About thirty pages are given to a series of completion exercises on the chapters. These are of little value and the space could have been more profitably used for better types of tests, or for a good list of references, and for pointing out some of the many unsolved problems thus giving the student an opportunity to consider this subject as a field for profitable research.

G. W. W.

Elementary Practical Physics, by Newton Henry Black, Assistant Professor of Physics, Harvard University, and Harvey Nathaniel Davis, President of Stevens Institute; Formerly Professor of Mechanical Engineering, Harvard University. Cloth. Pages viii + 710. 13 × 20.5 cm. 1938. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price \$2.00.

This book replaces *New Practical Physics* by the same authors which was published in 1929. The chief criticisms of the former Black and Davis texts were directed against the difficult arithmetic involved in the numerical problems. This defect has now been corrected; the problems are presented as carefully graded lists with the most difficult ones set off by asterisks. Many of the descriptive and explanatory sections have been completely re-written, new illustrations provided, and recent discoveries and applications included. The text is attractive in every respect, reliable, and modern. The authors must have dedicated themselves to the job of making physics interesting and useful to the boys and girls of the secondary schools. The predecessors of this text have enjoyed a wide circulation and adoption. This edition deserves even greater popularity.

G. W. W.

Glossary of Physics, compiled and edited by Le Roy D. Weld, Professor of Physics in Coe College, Cedar Rapids, Iowa. Cloth. Pages x + 255. 13.5 × 10.5 cm. 1937. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York, N. Y. Price \$2.50.

In mastering any science the vocabulary is a topic of prime importance. Elementary textbooks generally emphasize the new technical terms as they are used but the definitions are not always easily found when needed for reference, and no text can be complete in its definitions of all terms needed. This book gives comprehensible definitions of over three thousand terms used in the literature of physics. A random sampling shows that the selection is highly commendable and the discussions concise, accurate, and intelligible. Many references are given to show the use of the terms in current or classical physics literature.

G. W. W.

Handbook of Chemistry and Physics, edited by Charles D. Hodgman, Associate Professor of Physics at Case School of Applied Science. Twenty-second Edition. Cloth. Pages xviii+2069. 10.5×17 cm. 1937. The Chemical Rubber Company, 1900 W. 112th Street, Cleveland, Ohio. Price \$6.00 in United States and Canada, and \$6.50 in Foreign Countries.

The 22nd Edition of the *Handbook of Chemistry and Physics* is now ready for distribution. Each successive issue becomes more inclusive. New data in this edition include earth data, food tables, flame spectra, gravity acceleration data, lowering of vapor pressure of salts in aqueous solution, meteorological data, relative humidity, and additions to tables on gravimetric factors, index of refraction, preparation of solutions, radio tubes, etc., etc. The *Handbook* is indispensable in either the school or commercial laboratory.

G. W. W.

LIFE PRODUCED WITHOUT CHROMOSOMES

The genes and chromosomes, theoretical carriers of inherited traits and control elements in the growth and development of living organisms, may not be so important as once believed, according to experiments made by Dr. Ethel Browne Harvey, of the Department of Biology of Princeton University. Her success in developing, to the 500-cell stage, eggs that contained no nucleus or germ structure, in which the genes and chromosomes are located, questions the transmission theory of the genes and chromosomes.

Heretofore considered the masters of the complicated vital process which results in the formation of new cells that change an egg into a living body, the chromosomes with their layers of genes are now tossed back into the field of mystery.

Dr. Harvey performed her experiments on the egg of the sea urchin, doing some of her research work at Woods Hole, Mass., and some at Naples, Italy. Separating the eggs into four parts by subjecting them to a centrifugal force of 10,000 times gravity, she found that only one of the four parts contained the nucleus and chromosomes.

The Harvey-Loomis Centrifuge Microscope, developed in the laboratories of Bausch & Lomb, was the instrument with which Dr. Harvey observed the breaking apart of the eggs. But since the non-nucleate half of the eggs cannot be recovered in the centrifuge-microscope slide and are not in sufficient quantity, the experimental material was obtained by centrifuging the eggs in hematocrit tubes on a high-speed electric centrifuge.

Dr. Harvey developed the portions of the egg containing no nuclei and in some cases brought about the growth process without intervention of the male. This process she terms "Parthenogenetic merogony." She has been able to keep alive for as long as thirty days the organism that resulted from these fatherless, chromosomeless eggs. Erratic in development, the eggs did not divide into two daughter cells in successive stages but instead developed radiating structures in their protoplasm, called "asters," which usually accompany formation of a new set of chromosomes in the normal cell. These were visible also in the parthenogenetic merogonic cells that split into two cells as normal eggs do.

Chief distinction between the cells without a nucleus and the normal cell is that the former do not differentiate or develop into new forms. The other difference concerns size. In the organisms that lived longest, large cells developed in their central portion while the outer layer was composed of small cells. The organism as a whole, differing from normal forms, does

not develop beyond the blastula stage. It remains in the egg state and does not transform into a free-swimming organism.

The extraordinary development achieved by Dr. Harvey is to separate the egg produced by the mother into fractions, only one of which contains the nucleus and chromosomes. She then eliminated the chromosome contribution of the mother by developing the fractions containing no nucleus and no chromosomes. Finally she eliminated the father's contribution of chromosomes by fertilizing the eggs in the absence of any male element. This was accomplished by placing them in a solution of sugar and salt. The eggs grew without the vital element of father or mother, without chromosomes, developing apparently from no more than a protoplasmic jelly.

Dr. Brown's development of eggs without chromosomes passes back to the geneticists a problem that seemed on the way to solution. They have maintained that growth and development of the organism from the single egg cell is controlled by chromosomes. Now it appears that the cytoplasm, or jelly-like substance in the egg, contains within itself the possibilities for self-growth. Heretofore it has been considered an inert chemical storehouse of food materials which the chromosomes fashioned into structural duplicates of themselves and other vital substances needed for growth.

GOVERNMENT'S SERVICE TO YOUTH AS A SAFEGUARD FOR AN ENDURING AMERICA*

BY ROBERT FECHNER, *Director*
Civilian Conservation Corps, Washington, D. C.

The young men sent to the camps have improved in health, physical stamina, morale and employability. Their sojourn has made them better and more useful citizens.

Approximately 1,850,000 young men and more than 150,000 war veterans have been enrolled in the CCC camps since April 5, 1933.

The educational program for each camp is organized and conducted to fit the needs of the enrollees within the camp. Individual needs are recognized and met in the educational programs conducted after hours. The CCC camps are not militarized. They are not military camps although they are in charge of Reserve Army Officers. In the CCC, young men have learned discipline, sanitation, acquired physical hardihood and have become better citizens.

A few months in the outdoors as members of the CCC worked a transformation in these boys. Although the changes registered in the physical condition of the boys were most noticeable to the casual observer, they were no more outstanding than those effected in their mental outlook. Because of these things they have learned in the CCC they will be better citizens when they return home. Had it not been for the CCC, this country would have been further plagued with youthful criminals during the past four years, as it was beginning to be during the early years of the depression. Life, work, and training in the Corps unquestionably do contribute to crime prevention.

You may ask what has all this to do with Defense? When an untrained and often defiant youth learns first-hand of some of these things I have mentioned he is on the road to becoming a good citizen—and the best defense—whether the enemy is within or without—any country can have is a fine, healthy citizenry—and that is what the Civilian Conservation Corps is giving to this country.

* Abstract of address delivered at Thirteenth Women's Conference on National Defense for an Enduring America at the Mayflower Hotel, Washington, D. C., Wednesday afternoon, January 26, 1938.

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